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PREVIEW OF

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CONTENTS

Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

SPECIAL SECTIONS

DEPARTMENTS

ON OUR COVER

Northern Pacific geologist J. W. Keim checking photogeology in the field on a stereo pair. For a complete discussion of how Northern Pacific evaluates mineral potential on its lands, see pages 33 to 35.

Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $10.00. Single copies, $0.75. February Annual Review Issue, $1.25. Second class postage paid at Washington, D. C., and at additional Post Office, Lancaster, Pennsylvania.

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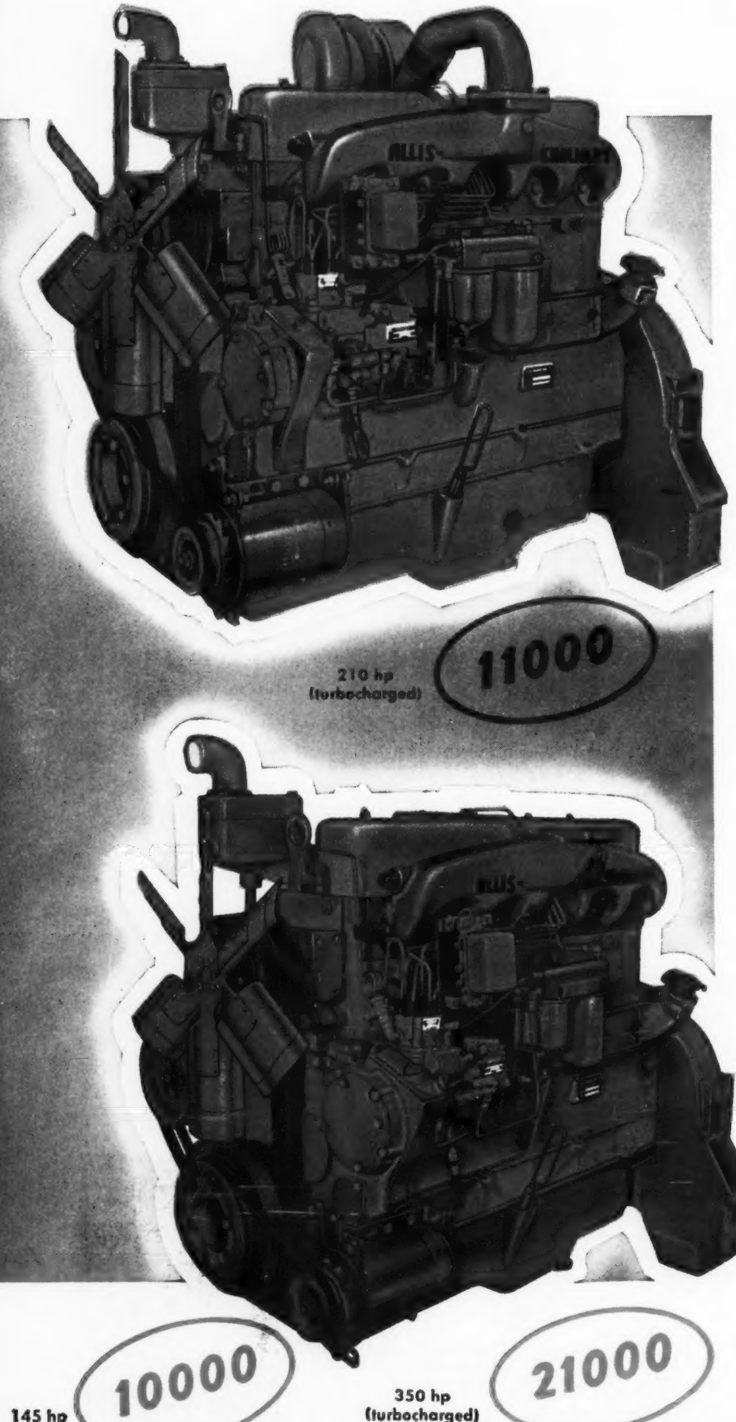

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***POWER* FOR A GROWING WORLD**

BE-24

featured

IN THIS ISSUE—and the AUTHORS

OPEN PIT MINING OF BAUXITE IN ARKANSAS

Reynolds Mining Corp. uses a three-panel system of open pit mining to achieve maximum bauxite ore selectivity and to keep stockpiling at a minimum. Stripping of the deposits is done in two cuts with a 10-yd capacity electric dragline equipped with a 200-ft boom. Ore is extracted mainly with 4 and 4.5 yd draglines operating on top of ore because of the poor support offered heavy equipment on the clays underlying the deposits and exceptionally wet conditions in the mines during much of the year.

PROGRESS IN VENTILATING CONTINUOUS MINING SECTIONS

The introduction of continuous mining made the problem of face ventilation and dust control more acute. The coal industry's approach to this critical problem is fully explained in this factual review of the progress being made. Emphasis is on tests involving two different methods of ventilating the face region with auxiliary fans—exhaust and forcing methods—with the advantages and limitations of each considered. The report also reviews several methods of installing fans and tubing and points out the advantage of a-c power for auxiliary fans.

GEOLOGIC RECONNAISSANCE OF LARGE AREAS

An extensive reconnaissance program calls for using the most advanced prospecting methods available. Northern Pacific Railway Co. in evaluating lands acquired under the Land Grant Act is actively developing a program in which eight stages of exploration activity are involved. These are cited by the author in discussing a project on a 2500 sq mile tract in northwestern Montana.

HOW SHALL WE TURN THE WHEELS?

"Without the wheel and its development, our present mechanical age is inconceivable." The author points this out as he reviews the history of the wheel and the power as applied to it, and delves into today's and tomorrow's applications of electric wheel propulsion. He also discusses the hydraulic power wheel, which is expected to eliminate gears entirely, and the advantages and limitations of a-c and d-c. Full attention is given to the part that electric wheels are likely to have and to play in the coal industry.

(CONTINUED ON PAGE 5)

Julian A. Fuller and J. R. Krause have both been with Reynolds Mining Corp. in Arkansas since 1947. Fuller is currently mine superintendent of open pit operations, before which

J. A. Fuller

J. R. Krause

he served in various capacities from mine planning and development to ore grading and production control. His early experience was gained in tin mines in England and underground zinc mines in Tennessee. Krause is chief engineer at Reynolds Arkansas operations. He joined the company in the capacity of open pit mining and stripping engineer.

C. H. Patterson has devoted his life to coal mining in Pennsylvania and West Virginia, serving in such capacities as mining engineer, assistant mine foreman, mine foreman and superintendent. He is presently employed as safety director for Rochester & Pittsburgh Coal Co.

Ernest E. Thurlow has been chief mining geologist for Northern Pacific Railway Co. since 1959. His early experience in the mining industry was gained in Butte, Mont., where he was a sampler and geologist for three years with Anaconda Co. In 1944, Thurlow transferred to Anaconda's Chuquicamata, Chile, operations where he remained until joining the Atomic Energy Commission in 1947. He was with AEC for 11 years, rising to manager of the Denver Area Office, before becoming chief geologist for Marcona Mining Co. in Peru in 1958. In 1959, he was appointed chief mining geologist of Northern Pacific.

Wayne H. McGlade's broad background in electrical and mechanical engineering plus the field of business makes him eminently qualified to report on, "How Shall We Turn the Wheels?" Presently manager of Product Development, LeTourneau-Westinghouse Co., he had previously served 19 years with the Adams Division in various engineering and manufacturing positions. He was also assistant to the executive vice president of LW from 1955 to 1959.

new

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Challenges Comparison

50% Higher Drilling Speed and Easier Operation Assure Maximum Production at Lowest Capital Investment

Never before in the history of rock drilling has there been a feed-leg drill that could do so much, so easily, as Ingersoll-Rand's new JR-300 Universal Jackdrill. On performance alone, it is 40 to 60% faster than preceding models.

The JR-300 is a lightweight, completely integrated rock drill and flexible air-feed leg unit designed for faster, easier drilling in any position. Three feed legs are available with this new machine: conventional single-acting, telescopic and a new double-acting automatically retractable feed leg. All controls are conveniently grouped on the backhead and the feed handle has a two-position button for feed release or leg retraction which reduces steel changing time and speeds setups.

The same fine performance and design features are available in the new R-300 Stoper and J-300 Jackhamer, simplifying parts inventory where all three types of machines are used. For a new high in drilling speed and economy, ask your Ingersoll-Rand representative for a demonstration of the new JR-300 Universal Jackdrill—or send for a copy of Bulletin 4219 today.

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A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

(CONTINUED FROM PAGE 3) **IN THIS ISSUE—and the AUTHORS**

CONVERSION OF A DRUM HOIST TO KOEPE FRICTION TYPE

The Bristol mine hoist was at its depth limit, but development plans called for sinking the shaft an additional 250 ft. After studying several plans to extend its hoisting depth, the company converted its drum hoists to the Koepe friction system to solve the problem. In addition the new system increased hoisting capacity by 35 percent. In the future it is expected that the mine can be further deepened 500 ft by using a flattened strand pull rope.

EXPERIENCE WITH A-C MINING

An engineer with a background of 37 years in the coal fields describes one mine's experience with a-c mining. After reviewing the factors which dictated the selection of a-c as a power medium, he describes the system installed and outlines the results achieved with emphasis on savings in maintenance, improvement in operating time, and an improved safety record. His frank account of some of the hurdles encountered proves that the company used good judgment in deciding on a step-by-step evolution from d-c to a-c.

MODERN THEORY OF ELECTRICAL HIGH TENSION PROCESS

The original methods of charging particles by induction or conduction resulted in forces which were of limited value in making mineral separations. Modern high capacity machines are dependent on high electrical potential and efficient use of ionic particle charging. Barthelemy explains ion bombardment charging, particle behavior in a static field, and operating principles of high tension machines.

PERSONNEL EVALUATION AND SELECTION

Here is a fresh approach to the problem of personnel evaluation and selection that underscores the importance of "self appraisal" in learning to evaluate and select other people. It is almost impossible to do a sensible job of selecting and evaluating without knowing yourself, according to the writer. He also delves into two other topics: (1) the necessity of a selection plan in order to continue a proper evaluation and selection process, and (2) the importance of instituting a system of continuing education so that the best type of employe will be available at the time of selection.

COMPUTERS IN THE MINING MANAGEMENT SYSTEM

Computers can comprehend, judge, forecast, make decisions, and command when equipped with reporting, communication and automatic language translation equipment, and for these reasons they can relieve management of an ever increasing burden of detail. In a well designed management system, computers have true worth in the control and growth of a business, its yield and its profit.

For the past eight years James R. Gronseth has been mechanical engineer for the Iron Ore Department of Inland Steel Co., where he is in charge of all mechanical, electrical, and structural work. Before joining Inland, he was with Roland C. Buck, Inc., Engineers, a heavy construction company in Superior, Wisc. Gronseth did much of the preliminary planning and engineering for the Koepe friction installation at Inland's new operation, Caland Ore Co., Ltd., in Ontario.

Otis G. Stewart, executive engineer-Coal Mining, Union Carbide Metals Co., has been actively engaged as a mining engineer in both strip and underground operations since 1923. For the past 29 years he has been with Union Carbide at its West Virginia and Ohio mining operations.

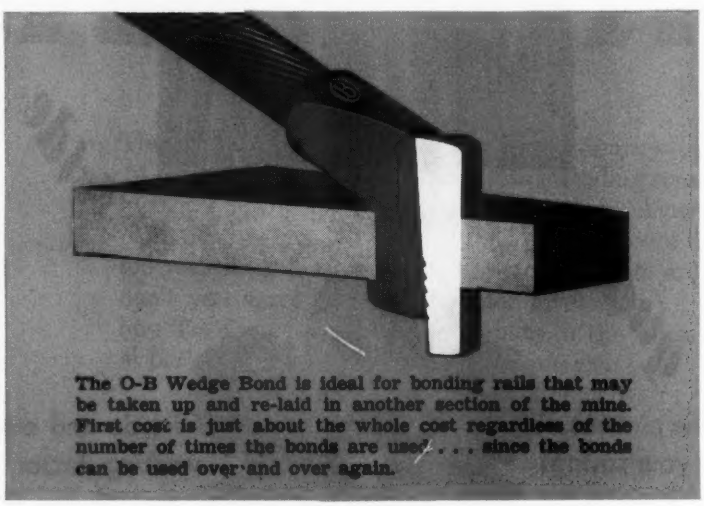
R. E. Barthelemey has been an independent consulting engineer in Jacksonville, Fla., since 1959. Before that, he was director of research for Carpco Research and Engineering, Inc. for four years. He has worked in numerous consulting, managerial, and research posts over the past 35 years in Europe, Asia, Africa, and North and South America.

John N. Crichton, executive vice president, Johnstown Coal & Coke Co., is thoroughly familiar with every phase of the company's operation, having started at the bottom and worked his way through numerous assignments. Since 1946 he has served successively as superintendent, general superintendent, general manager, & vice president-operations, being elected to his present position in July 1959.

Walter H. Schwedes has worked extensively on applications of automation techniques in ore concentration and agglomeration processes. He joined General Electric Co. in 1939 and became senior engineer-mining six years ago. His major interests have been heavy apparatus systems for mine hoists, power excavators, and mineral processing plants.

AVERAGE INSTALLATION TIME:
ONE MAN-HOUR

It appears that you can make one dollar do the work of four by using wedge bonds instead of welded bonds . . . and, in many cases, this is true. Equally, there are other cases where welded bonds—though more costly to install—can cut your overall expense in track maintenance and power consumption. ■ The trick is knowing exactly what kind and type of bond will best fit the job to be done . . . that's where O-B comes in. We make all kinds of bonds . . . and our District Managers have the most up-to-date information on how and when to use them. ■ If you have a railbonding job coming up, you should talk to our local O-B man. There's a bond that best fits your job and he can tell you which one to use (and why). Using the right one saves on installation and perhaps will save you even more on maintenance and operation!



The O-B Wedge Bond is ideal for bonding rails that may be taken up and re-laid in another section of the mine. First cost is just about the whole cost regardless of the number of times the bonds are used . . . since the bonds can be used over and over again.

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USS Tiger Brand hoist ropes and boom supports help keep this 25-yard dragline on the job around the clock.

USS Tiger Brand hoist ropes last over 1,800 hours on 25-yard dragline

This big dragline works around the clock—three shifts a day—at the Harmattan Mine of Fairview Collieries Corporation, Danville, Illinois. The twin hoist ropes last over 1,800 hours in this rugged service.

The USS Tiger Brand hoist ropes are two inches in diameter and 450 feet long. They are made of tough Monitor steel which has a reputation for long service on jobs like this.

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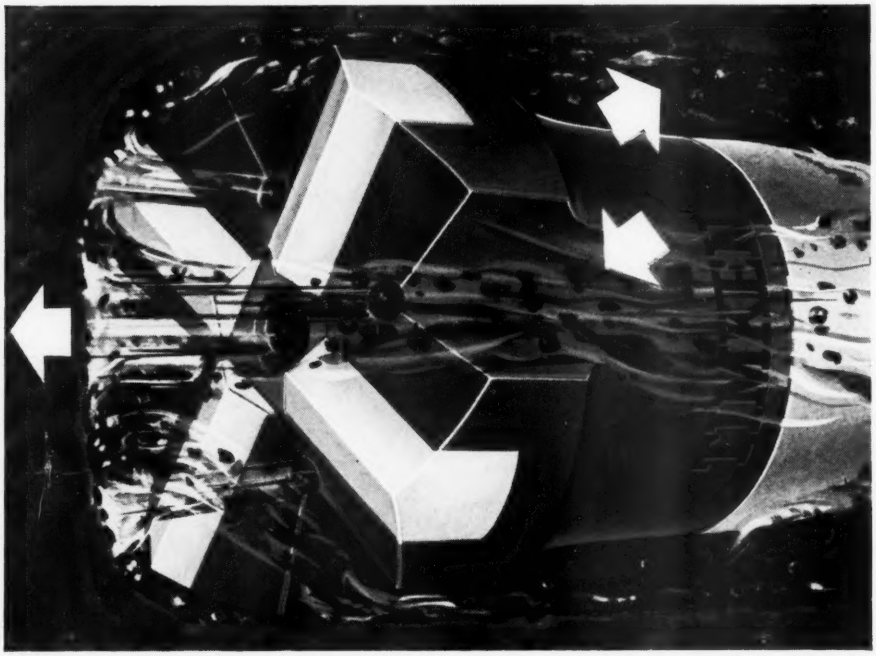

Timken® threaded bits CLEAR CHIPS FASTER

When you drill, you want to drill rock—not loose chips. You want to prevent wasteful chip-clogging. And you *can,* by using Timken® threaded carbide insert bits. The five front hole design, pioneered by the Timken Company, shoots air or water directly against the rock face to speed chip removal. And with the deeper, wider wing clearance chips clear faster. You save time, speed drilling.

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Timken bits are used by more miners and contractors than any other removable bit. One reason is that with Timken bits you get the kind of "on the job service" from Timken field engineers you can't get anywhere else. Timken threaded bits are available in a complete range of sizes and types. For full details send for free brochure, "Timken Removable Rock Bits". The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

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ALL-STEEL MULTI-USE

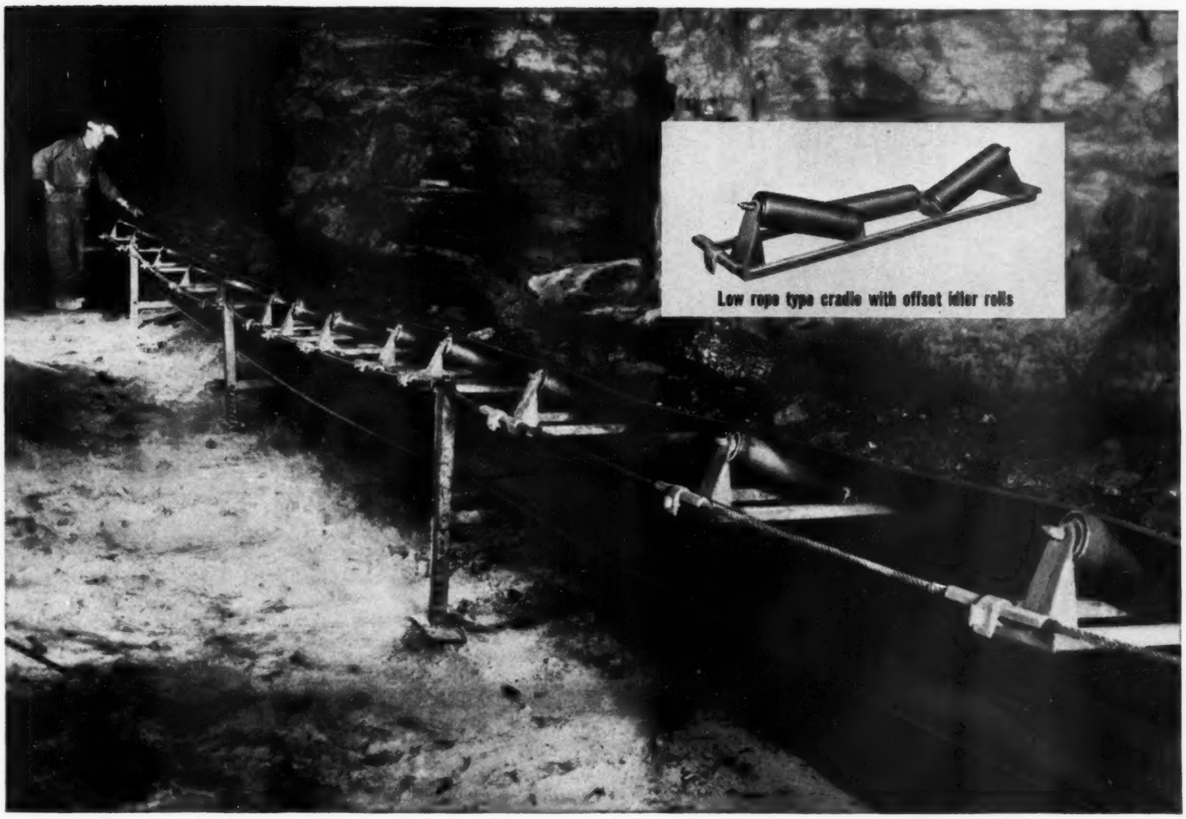
This Timken bit gives lowest cost per foot of hole when you can drill out full increments of steel.

TAPERED SOCKET BIT

Tapered to give strength of one-piece steels. Has the same speedy chip-removal features as the threaded bit shown above.

TIMKEN®

removable rock bits



Jeffrey repeat orders prove conveyor production performance

Almost unbelievable performance is demanded of most mine equipment, and belt conveyors are no exception. These are required to function under most adverse conditions. Few can take the punishment long enough to win the approval of alert, progressive mine operators. Jeffrey wire-rope type conveyors can. Proof of that easily can be seen in repeat orders placed by leading coal producers. The Clinchfield Coal Company, Dante, Virginia, is one of these. Ten miles of Jeffrey wire-rope type belt conveyors have been purchased for their Moss #3 Mine.

Year	Units	Total Feet
'58	6	8,000
'59	4	9,500
'60	4	13,000
'61	8	22,500

These belt conveyors are about equally divided between 36-inch and 48-inch widths.

Jeffrey wire-rope type conveyors last longer because the wire rope provides a spring-like action to cushion the loaded belt as it rides over the idlers. Permaseal® Idlers are sealed to keep out dust and dirt...give years of maintenance-free operation.

For complete information about Jeffrey wire-rope type conveyors, write for Catalog 970. The Jeffrey Manufacturing Company, 958 North Fourth Street, Columbus 16, Ohio.

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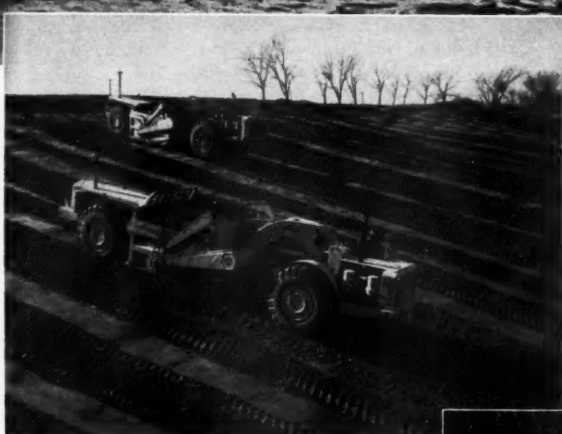

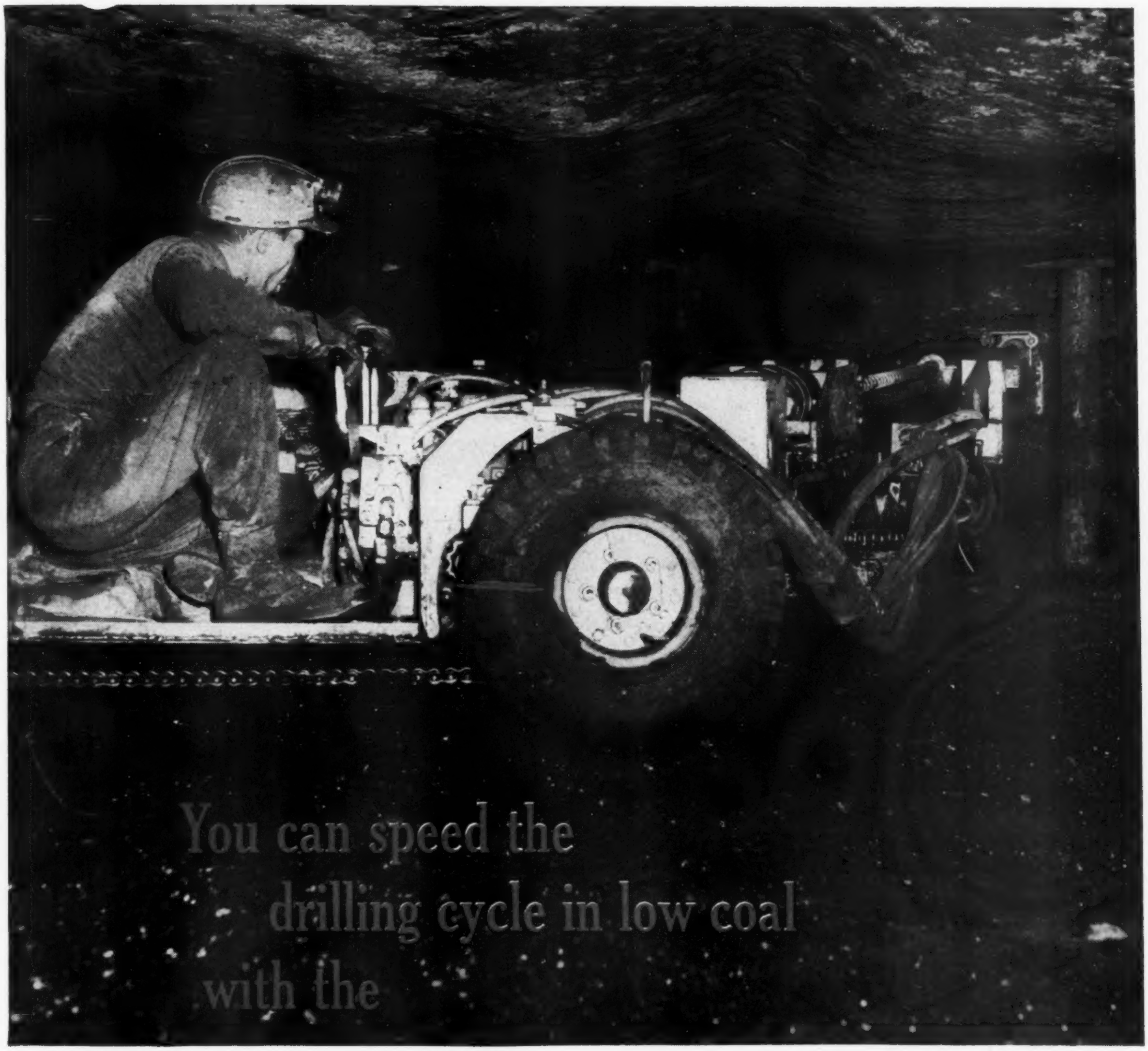

ALL NEW JOY CD-61 DRILL

Operators of seams as low as 29″ can now mechanize their drilling with Joy's new CD-61 coal drill. Two models are available with machine heights of 24″ and 28″. The lower model drills horizontal holes from the roof to 20½″ above bottom. The 28″ model drills from the roof to 24½″ above bottom. The boom swivels a full 185°.

The entire machine is compact and maneuverable. It has 4-wheel drive with tractor type steering. The drill has a 10 foot continuous auger feed to eliminate auger changes. The operator's station is located midway between front and rear tires on the right hand side of the machine. He remains safely away from the face during the complete drilling cycle.

Get complete details on this high speed, high production drill for low and medium-low coal.

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY

Coal Drills	Coal Loaders	Coal Cutters	Shuttle Cars	Continuous Miners

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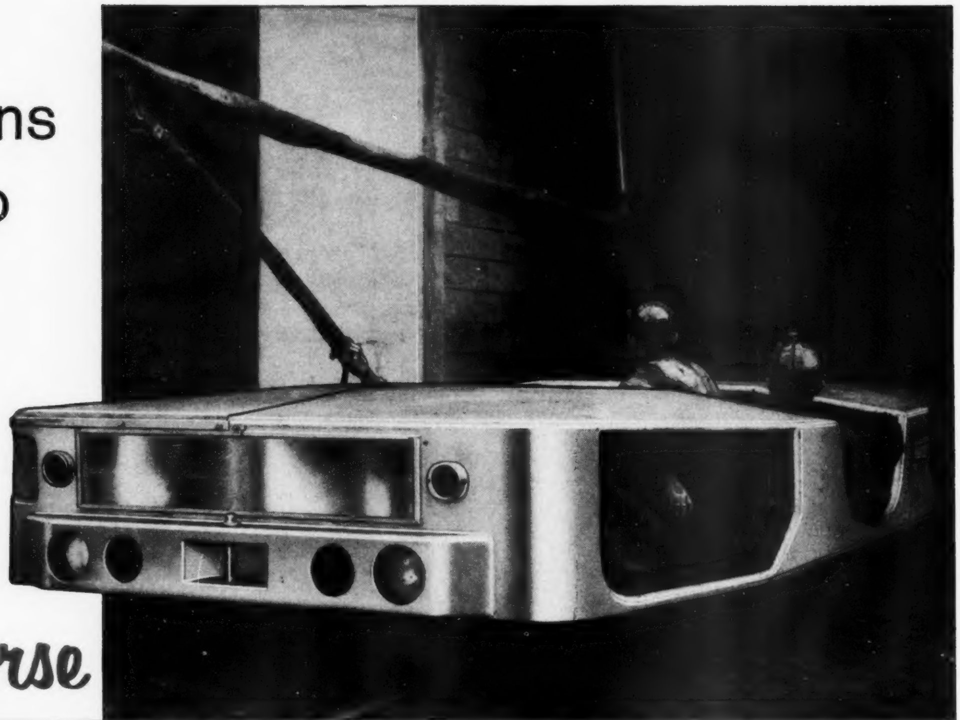
Reasons why so many mines use the Lee-Norse LOW mine portal bus



1. FAST—Cuts portal to portal time as much as 50%.
2. STREAMLINED—Transports 11 to 13 men in safety and comfort in low seams.
3. SAFETY—Exclusive split-roof allows operator full directional vision—trolley pole easily reached. Quick acting hydraulic truck-type brakes on each axle and on the traction gearmotor. Independent mechanical hand parking brake each axle.
4. POWERFUL—Self-propelled by sturdy traction-type 15 HP gearmotor (250 or 550V—DC).
5. RUGGED—Quality built to withstand the hard usage of 'round the clock mining!
6. LOW MAINTENANCE—Simple design—easy accessibility.
7. OPTIONAL FEATURE—Electric dynamic brakes for plus safety on severe grades.

Lee-Norse Company
CHARLEROI, PENNSYLVANIA
Specialists in Coal Mining Equipment

You can count on higher output from your production haulers when roads, as well as loading and dumping areas are maintained regularly. LeTourneau-Westinghouse graders handle these and other "housekeeping" duties *faster* . . . *at lower cost* . . . than any other grader of comparable size.

A practical way to speed "routine" road maintenance

Most of your grader work is probably a lot like that pictured here . . . "routine" maintenance chores. They require nothing unusual in the way of power, little special equipment, and ordinarily they can be handled without "paper work." But, the *difficult* thing about these jobs is that there are so very many of them to do all of the time!

That's why many mines and quarries choose LeTourneau-Westinghouse Model 440 and 550 graders for this type of work. Owners prefer them because these LW machines are *faster* than all other graders in their power class . . . they can *complete* more assignments in less time.

25% faster travel than average

Consider travel speed, for instance: The "440" and "550" get from job-to-job at speeds to 25.2 mph. *That's 25% faster than the average top speed of any other "medium-size" grader on the market.* And with a top *reverse* speed of 13.2 mph, these LW graders are a full *59%* faster than the average!

The "440" and "550" *work* faster, too. With 8 forward speeds and 4 reverse, your operators have more full-power speeds to choose from, and on most operations they work from 1 to 3 mph *faster* per pass.

MPH advantages, however, are only *one* reason why LW motor graders get more work done faster. To understand their true value it will be worth your while to see an LW operate at your pit. We will be happy to demonstrate the size grader that fits your needs. 7 models, 85 to 190 hp. Ask for complete details.

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A Subsidiary of Westinghouse Air Brake Company — *Where quality is a habit*

Editorial

MINING CONGRESS JOURNAL
ROBERT W. VAN EVERA, Editor
March 1961

Brain Picking

MINING CONGRESS JOURNAL has initiated a program to publish a limited number of translations of Russian reports dealing with interesting phases of mining technology. These articles are selected by our editors and translated exclusively for the Journal.

The first of these reports, "Radioactive Pickup for Automatic Control of Mining Machinery," appears on pages 45–47 of this issue. It came from the November issue of UGOL' (Coal), a periodical of the Russian government—which, through a number of separate agencies, is responsible for *all* of the printed material in that country. In the May issue, the Journal will carry its second translation, "Dustless Breaking of Rock by Electric Methods." This report was published recently by the Institute of Mining of the Academy of Sciences of the USSR.

These plans for bringing to our readers information on Soviet mining research are admittedly an experiment. While the first two of these articles include some extremely interesting research data, neither indicates to what extent the principles developed by the Russians have found practical application. The important question, of course, is whether their work can help the American mining industry.

It is significant that the Communists have made it a point to subscribe to all of the free world's trade publications that they can, and the influence of the information they have obtained is apparent in some of the machinery and methods used in Russia.

Along with their determination to "pick our brains," they are also making an all out effort to conduct a sound research program of their own. Our search of Soviet literature reveals that their researchers are prolific writers. This, we believe, is part of a well-conceived plan not only to use the best technology of the free world, but to add their own refinements and improvements. The wisdom of this philosophy should not be ignored, regardless of America's superior productivity.

Technological breakthroughs are an essential part of progress, but these advances cannot always be brought forth on schedule. Like gold, they're where you find them, and Russian or East German scientists have as good a chance of coming up with solutions to technical problems as anyone else. Because the Soviet Government realizes that successful research requires free and imaginative meditation, it allows much more freedom to its scientists than to other citizens—a powerful incentive.

Since our own country is well ahead of Russia in mechanization and mining technology, it would seem that we should be better able to make practical use of research developments. We don't advocate handing our know-how to the Russians—although they have no trouble acquiring it. But certainly we should take a close look at what is being done abroad and use any worthwhile information, no matter where developed, for our own progress. Americans, too, can profit by picking others' brains.

The Journal will be pleased to hear from any of its readers as to whether the material included in the translations in this and future issues has actual value to the American mining industry. Should the program be continued, terminated, or expanded?

By J. A. FULLER
Superintendent of Surface Operations
and
J. R. KRAUSE
Chief Engineer
Reynolds Mining Corp.

Open Pit Mining of Bauxite in Arkansas

Major problems in mining bauxite at Reynolds' Section 35 mine are concerned with keeping water out of the pits, preventing ore contamination, and maintaining close engineering control over ore extraction operations

OPEN pit mines and mining methods are as varied as the materials mined and the locations of the mines. It is the purpose of this article to discuss some features of open pit mining of bauxite deposits in Arkansas as practiced by Reynolds Mining Corp.

The Arkansas bauxite deposits and mining districts are located in Pulaski and Saline Counties, near the center of the state. The Pulaski County district is approximately five miles south of Little Rock and encompasses a series of deposits that lie a short distance from the flanks of a nepheline syenite outcrop known as Granite Mountain. The deposits in Saline County are associated with two separate partly-buried hills of nepheline syenite. Most of the bauxite deposits are found in the areas immediately surrounding these crystalline masses and are directly associated with the weathering of nepheline syenite.

Arkansas Bauxites Fall into Two Types

Bauxite is the principal source of aluminum. It is the name applied to a wide variety of aluminum ores consisting mainly of hydrated oxides of aluminum. These ores vary widely in the amounts and kinds of impurities. The principal alumina minerals composing bauxite are the monohydrates diaspore, boehmite, etc., and the trihydrate, gibbsite. Impurities are generally various iron minerals, such as goethite, hematite, and siderite; silica, usually in the form of kaolin and halloysite; and the titanium minerals, rutile, ilmenite and leucoxene.

Bauxites are divided into classes depending upon their end use. They are chiefly metal grade, abrasive grade, chemical grade, high iron and bauxitic clays grading into kaolinitic clays. Reynolds operations in Arkansas are confined to the mining of bauxites for metal purposes.

In general, the bauxite deposits in Arkansas fall into two types; those that formed and remained essentially in place and those that have been transported to their present position by soil creep and stream action.

Bauxite differs greatly in its character and physical properties. In hardness it varies from a soft earthy or clay-like material to a hard, tough, sometimes brittle material. In color it ranges from light gray through tan and brown to red. Color is not necessarily an index of grade. Although a wide variety of forms are evident, the three basic types are granitic, pisolitic, and fine-grained structureless bauxite.

Arkansas deposits range from a few feet to more than fifty ft in thickness. Deposits which outcrop to those buried under 600 ft of sediments are known.

The climate of central Arkansas varies from warm humid summers to moderate winters marked by occasional snow storms. Average temperatures range from 42° in January to 81° in July with extremes varying widely from these means. Rainfall has averaged 47.3 in. at Little Rock.

A large number of small creeks and branches cross the area providing a complicated drainage pattern. In spite of the number of creeks, the area is poorly drained and subject to flooding.

Current Production Mainly From Two Companies

Early in 1942, Reynolds commenced bauxite mining by sinking a shaft on the Hurricane Creek ore body near the town of Bauxite in Saline County. The ore was shipped to Government stockpiles located nearby.

During World War II the stockpiling program by the U. S. Government, through Metals Reserve Co., brought numerous other mining companies into the district.

In 1946, Reynolds acquired the Hurricane Creek alumina plant from Metals Reserve and all of the subsequent production from Reynolds Mining has been delivered to this plant. When the Government ore purchasing program came to an end, all the small independent producers who had been drawn into the field ceased operations, leaving only Alcoa and Reynolds as the major bauxite producers.

According to "Minerals Yearbook," during the ten-year period from 1950 through 1959, 15,697,000 long dry tons of bauxite were produced in Arkansas. During World War II, the state produced over 6,000,000 long tons of bauxite in one year (1943).

In 1959, Reynolds Mining delivered 744,000 long dry tons from open pit mines and 155,000 long dry tons from underground mines to the Hurricane Creek plant.

Reserves of Arkansas bauxites are difficult to estimate. Variable factors such as grade of ore (metal grade, abrasive grade, chemical grade), thickness of deposit, and whether open pit or underground ore, influence the result. However, in 1950 the United States Geological Survey estimated that in deposits over five ft thick there were between 5,000,000 and 6,300,000 long wet tons that would meet prewar specifications of not over seven percent SiO_2 and not over three percent FeO; 48,900,000 long wet tons that would meet War Production Board requirements of less than 15 percent SiO_2, less than six percent FeO, over 40 percent Al_2O_3 and not less than 32 percent of "available alumina," and 88,900,000 long wet tons of similar specifications but with no restriction as to iron content. It is generally admitted that although the latter grade is not presently commercial, this estimate is conservative.

Early Mining Efforts Confined to Outcrops

The earliest mining of bauxite was entirely by open pits developed from outcrops. Shallow churn drilling to explore the lateral extent of these deposits was used. Hand churn drilling was supplemented by mechanical churn drills and then by rotary rigs capable of recovering cores.

In December 1941, the U. S. Bureau of Mines engaged in an extensive exploration program which continued for four years. This project was one of those undertaken for the purpose of developing domestic sources of supply for critical and strategic minerals. Private companies have continued the search for and the development of bauxite deposits in Saline and Pulaski Counties.

The major source of open pit ores produced by Reynolds during the past several years has been the extensive holdings known as the Section 35 deposit, located near Bryant. The discovery of this deposit and the definition of the ore limits was the result of exploration and development drilling by Reynolds and the Bureau of Mines. This group of properties, including the bauxite deposit and adjacent spoil disposal lands, comprises approximately 1100 acres.

Outlying bauxite mine in Saline County, Ark. Underground ores, ores from the Section 35 mine, and ores from other open pits are blended to provide the Hurricane Creek alumina plant with a controlled grade of bauxite

The Section 35 ore body varies from 5 to 40 ft in thickness, is undulating and gently dipping to the north. The overburden ranges from 65 ft to 200 ft in depth. Mining to date has been concentrated in the southern area of the deposit where the depth of stripping has averaged approximately 95 ft, with a maximum of 140 ft.

Three Panel System of Stripping and Mining Employed

In order to provide the desired degree of flexibility, a three face or three panel system of stripping and mining is followed at this ore body. While one panel is being stripped, mining may be carried on in the other two panels, facilitating the delivery of a controlled production.

Initially, an entry cut providing access for mining was made, from which two separate box cuts were opened. After the bauxite was removed these box cuts provided spoil disposal for the development of adjacent panels. Both the entry and box cuts were effected by contract dragline and scrapers.

To continue this panel stripping, Reynolds, in 1950, purchased a ten-yd electric dragline with a 200 ft boom. Prior to this, the company contracted the stripping of all open pits in both Saline and Pulaski Counties.

Before stripping begins, complete plans are developed by the engineering department for each panel. These plans take into consideration, among other things, existing surface conditions, depth of overburden, haul road entry, thickness of ore, drainage and sump requirements, and spoil placement.

The panels are laid out both in plan and vertical section to analyze these varying conditions and resolve them in the most effective manner within the capabilities of the dragline. These panels are normally 140 ft in width and have varied from 900 ft to 1200 ft in length. A swell factor of 11 percent is used in planning of spoil placement.

Overburden Stripped in Two Cuts

In general, overburden removal is accomplished by means of two cuts,

Overburden removal is accomplished by means of two cuts, each of which approximates half of the total stripping depth. Pictured is a dragline excavating the second lift down to the ore horizon

each cut approximating one-half of the total stripping depth. Banks are cut with a slope of one to one. To provide a stable tracking surface for the dragline, the "first lift" is preceded by a shallow "trim cut," which removes surface sands and wet clayey gravel. Because "trim cut" material is not suitable for forming a spoil base, it is placed in the adjacent mined out panel in such a manner that it constitutes a portion of material that is later rehandled.

When the dragline reaches the end of the panel on the "trim cut" phase of the operation, it cuts its way down to a working level on top of the "first lift." Material from the "first lift" is cast into the bottom of the adjacent mined out panel. As the "first lift" progresses, a dozer levels the cast spoil to form a working surface on which the dragline will operate in excavating the "second lift." To minimize soaking of the spoil pile base, the dozer establishes drainage on the spoil pile bank. When the dragline reaches the end of the "first lift," it ramps itself down onto the prepared spoil bench in position to excavate the "second lift" down to the top of ore.

The last phase of the operation, that of rehandling the cast material, provides for the excavation of a drainage ditch 12 ft wide at the bottom, adjacent to the exposed face of ore, running the full length of the panel. In the course of excavating this ditch, a slope of one and one-half horizontal to one vertical is established on the spoil.

Material rehandled in the course of establishing the drainage ditch and spoil slope is cast above and behind the dragline, against the high spoil deposited from preceding panels. The tops of these piles are then leveled off to an approximate original surface elevation in such a manner that rainfall is conducted away from the excavation. The exposure to spoil failure, due to saturated ground, is minimized by eliminating the entrapment of water on the spoil. These refilled areas are available for stockpiles.

Dikes, Ditches and Sumps Minimize Water Problems

While excavating the "first" and "second lifts," the dragline creates a drainage berm 15 ft wide in the virgin overburden slope to collect not only the inflow of ground waters and rain falling on the panel slope but also bank wash material. This procedure reduces to a great extent the amount of bank erosion and resulting contamination of ore.

To prevent the inflow of surface waters, each panel is protected by dikes and ditches. Sumps are maintained at either end of the panel in the adjacent mined out area to provide for the collection of water.

In general, the overburden is a free digging material consisting of sand, gravel, sandy clay and lignitic clay. Occasionally, boulders and thin layers of siderite are encountered. Blasting is sometimes required to loosen dense clays and sideritic lenses.

Through experience it has been determined that in order to minimize the exposure of spoil failures the maximum uninterrupted height of dragline spoil must be restricted to approximately 55 ft. Berms of from 30 to 50 ft in width are established at these intervals during the construc-

Soft, plastic clays, which underlie the ore zones, do not provide adequate bearing to support heavy equipment. Heavy rainfall aggravates the condition and is among the factors which led to use of 4-yd and 4.5-yd draglines working on top of the ore for loading. Note drainage benches on pit slopes

tion of spoil piles. The slope from the berm to the base of the pile is one and one-half to one, and the slope above the berm is one and one-fourth to one. In addition to stability, these berms also provide a catchment for slope wash and conduct runoff to collecting sumps.

Variety of Earthmoving Equipment Is Used

The dragline normally operates three shifts per day, five days per week. The crew on each shift is composed of a supervisor, an operator, an oiler, and one combination groundman and dozer operator. A welder is employed on day shift only. On the basis of three-shift operation, five days per week, the dragline moves an average of 1,550,000 cubic bank yards per year. The present stripping depths require that approximately 50 percent of this yardage be rehandled.

Servicing and routine maintenance on the dragline are accomplished during each working shift. The dragline is radio equipped to facilitate communications with service departments. Reynolds maintains a 4160 volt distribution system in the Section 35 area to furnish power to the dragline and other electric units, including pumps. Ground fault protection equipment is installed at points of usage.

As auxiliary stripping equipment, company owned rubber tired scrapers are used where applicable.

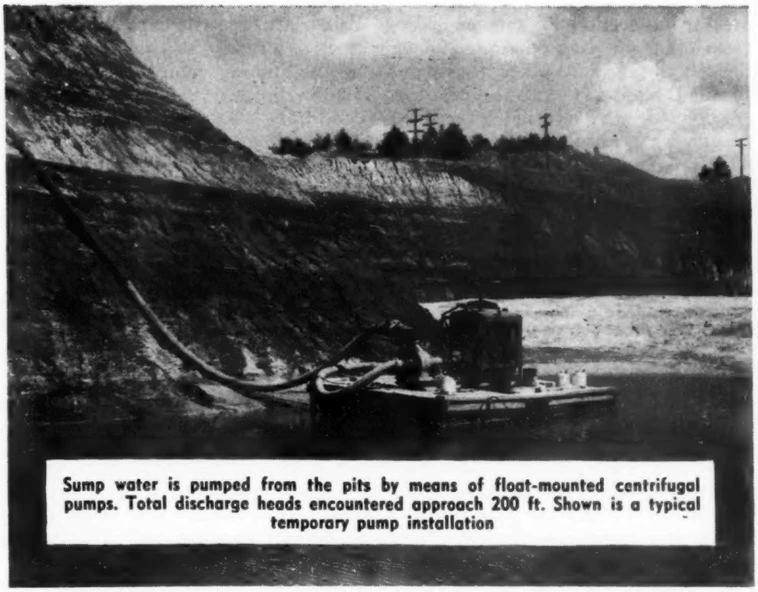
Reynolds' stripping requirements in areas other than the Section 35 ore body are handled by outside contractors. Various types of earthmoving equipment are employed, including rubber tired scrapers, dozers and draglines, shovels and Euclid loaders in combination with bottom dump trucks.

The company in 1948 initiated a program of reforestation in which loblolly and short leaf pine seedlings are planted on spoil piles and other suitable areas as they become available.

The routine of a three panel system of mining (stripping one panel while two panels are available for ore extraction) provides maximum selectivity of grades of ore, with a minimum amount of stockpiling, and flexibility of mining operations.

Engineering control plays an important and continuous role in the mining operations. Drill hole core analyses, plan and cross sectional maps, frequent surveys, and daily pit samples all contribute to the basic objective of extracting the desired grade of bauxite.

Reynolds maintains laboratory facilities for the complete analysis of bauxite. The proportions of free and combined water, alumina, silica, iron oxide, and titania are determined. Approximately 400 to 500 samples are analyzed per month.



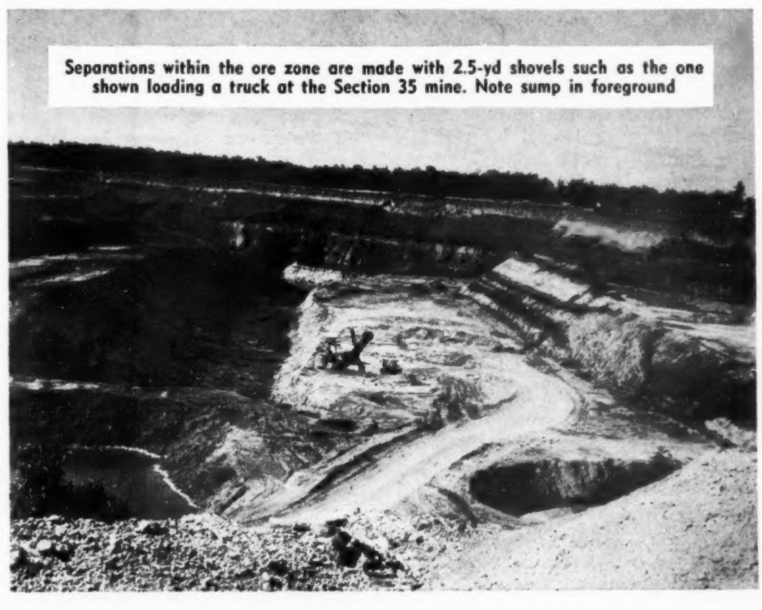
Sump water is pumped from the pits by means of float-mounted centrifugal pumps. Total discharge heads encountered approach 200 ft. Shown is a typical temporary pump installation

Ores from Several Operations Blended

To provide protection against silica contamination, bank and spoil pile drainage benches are established above the top of the ore. Bank erosion, not collected by the drainage benches, is cleaned up prior to and after each blast and prior to and during loading operations. Front-end loaders, bulldozers, and graders, together with shovels and dragline loading equipment, are utilized in keeping the ore clean.

Pit bottom drainage is directed to collecting sumps and provides a suitable base upon which spoil from succeeding panels is deposited. Sump waters, having a pH as low as 2.5, are pumped out of the pits by means of float-mounted centrifugal pumps through eight-in. or ten-in. aluminum pipes. Total heads encountered approach 200 ft.

To provide the Hurricane Creek alumina plant with the desired grade of bauxite, underground ores, selected



Separations within the ore zone are made with 2.5-yd shovels such as the one shown loading a truck at the Section 35 mine. Note sump in foreground

ores from Section 35 pits and ores from other outlying open pits (some located as far as 20 miles away) are blended. Each day's pre-selected ores are loaded and delivered directly to the plant prior to their analyses. Such a procedure necessitates both an intimate knowledge and familiarity with the various ore grades, their respective positions and availability, coordination of the mining equipment, and the cooperation of the operating personnel.

To maintain the desired grades of ore delivered, it is occasionally necessary to change the loading crews and trucks from one source to another during the shift. Such changes usually occur as a result of a reversal in the prior days analyses as compared to the estimate. An engineer schedules, supervises and coordinates the blending of ores. A normal day's delivery will average approximately 5000 tons from open pit and underground sources.

Truck-Mounted Augers Drill Blast Holes

Drilling bauxite for blasting purposes is accomplished with McCarthy Model V 106 auger drills mounted on standard 2.5-ton trucks. These drills are equipped with 50-hp gasoline engines. The rotary motion is provided by power take off from the gasoline engine whereas vertical motion is performed hydraulically. Blast holes are nominally five in. in diameter. Drill heads 4.5 in. in diameter, holding four ½ in. by ½ in. by 2.75 in. tungsten carbide insert bits are attached to 4.5 in. auger steel. This drill steel has a four-in. pitch, is six ft long, and weighs approximately 45 lb.

The hardness of the ore has a marked effect on the footage drilled per shift, as evidenced by the fact that footage ranges from 600 ft to 1000 ft per shift. Reynolds has tested numerous types of drilling equipment and although experimentation continues, it is felt that the auger drill is the most satisfactory type.

As with other open pit mines, the use of ammonium nitrate has permitted savings to be effected in blasting operations. At present, approximately 70 percent of the explosives used is ammonium nitrate, 10 percent of the total is 60 percent strength dynamite used as primer for ammonium nitrate, and 20 percent is waterproof packaged 4 in. by 16 in. cap-sensitive powder. Packaged powder is used only for wet holes. Detonation is accomplished by means of fuse, caps, and Primacord. Electric caps are not used as it is felt that stray currents from trailing power cables, lightning, or mobile radios would create hazardous conditions. Drill hole spacing and burden range from 10 ft by 10 ft to 7 ft by 14 ft, depending upon local pit conditions and requirements. Bauxite breakage averages approximately 3.0 tons per pound of explosive.

The close proximity of small towns necessitates controlled blasting to minimize possible property damage. From time to time consultants have been called in to analyze the effects of blasting. On one occasion during such a study, the passing of a small dump truck produced much greater "ground effect" than the blasting. Adherence to specific recommendations as to the number of delays and the size of the blasts is practiced. Delayed blasts are made by the use of millisecond Primacord delays. As an additional safety precaution, caps are not brought into the pit area until the end of the shift or until the shot is to be fired.

Ore Loaded with Draglines

In nearly all instances the bauxitic ore zone is underlain by soft, plastic clays. These clays do not provide adequate bearing to properly support either heavy loading equipment or loaded trucks. In addition, the annual rainfall of about 50 in. aggravates the poor bearing condition, traction becomes exceedingly low, and contamination control difficulties increase. These factors together with other important considerations have brought about the use of four-yd and 4.5-yd draglines to load most of the bauxite ore. The benefits of dragline loading become even more pronounced during the wet seasons.

Normally these draglines remove the ore in one or more cuts. Where conditions require, it is customary to make separation within the ore zone by means of 2.5-yd shovels. This combination of loading units gives good production and provides the required degree of ore selectivity.

Pit ramps do not exceed eight percent grade. The average length of haul from the Section 35 properties is three miles. Two sizes of off-the-highway hauling units are utilized, namely 15-ton and 22-ton trucks. The larger size trucks are equipped with torque converters. Loaded haulage speeds range from 22 mph for the small units to 28 mph for the large units. All trucks are weighed and sampled prior to dumping their loads. Haulage from outlying mines is accomplished by contractors' trucks. Mining and ore delivery is done on day shift only.

Haul Road Construction and Maintenance

The main haul roads are 35 to 40 ft wide and have a sub-base consisting of a minimum of three ft of compacted sand, clay, and gravel. In most instances, this base is over four ft thick. Grading, shaping, watering, and traffic have produced a smooth, hard surface.

In 1956, the company experimented with a 15 percent-latex asphalt seal coating over approximately three miles of main haulage roads. This surface of plastic asphalt sheds water excellently and withstands the heavy truck traffic without squeezing or forming ruts. It has been found necessary to resurface about every three years because spillage together with winter freezing and thawing tend to break down the waterproof seal. As with other well constructed haul roads, the prime requisite for the successful utilization of this thin, pliable, latex asphalt coating is a solid, unyielding base. The advantages of this type of surface are numerous, but primarily the cost of grading, rebuilding, and watering are eliminated, truck maintenance is reduced, and productivity is increased.

Repair and maintenance of most equipment is performed at centrally located company shops. Large shovels and draglines are repaired and maintained in the field.

Radio Communications Expedite Work, Minimize Down-Time

A program of preventive maintenance is followed. Shovels, draglines, trucks, tractors, and other units are scheduled out of service, steam cleaned, inspected, and repaired on the basis of hours operated. Routine servicing and some maintenance is performed on the evening shift. Prior to the beginning of each shift, tires of hauling units are gauged and the pressure adjusted if necessary.

All service trucks as well as pickup trucks operated by supervisory and maintenance personnel are equipped with mobile radio units. In addition, fixed units are installed in the main shops, warehouse, and mine office. Radio communications expedite the work in general and minimize downtime due to equipment breakdowns.

The safety of all operations is under the general direction of a safety director working in cooperation with all supervisors. Weekly safety meetings are held for all hourly personnel.

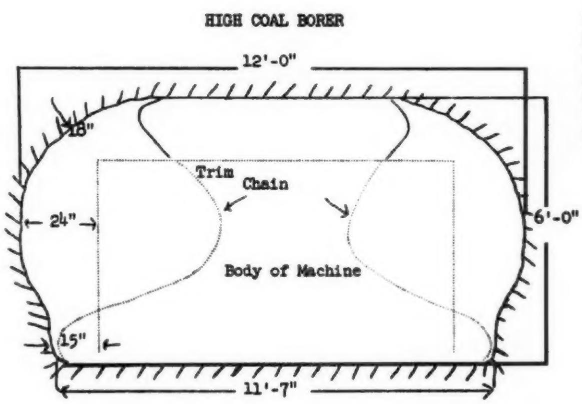


Fig. 1. Because the boring-type machine develops the place to its own working width, it blocks the immediate face area, posing a difficult ventilation problem

Progress in Ventilating Continuous Mining Sections

By C. H. PATTERSON
Safety Director
Rochester & Pittsburgh Coal Co.

Two different methods of ventilating the face region with auxiliary fans are being tried by the coal industry

Adequate ventilation and dust control are the major factors in preventing ignitions in coal mines. Either dust or gas may become critical if an adequate amount of pure air is not provided and the dust produced in the process of mining is not suppressed.

Prior to the advent of continuous mining, face areas could be properly ventilated by the use of line canvas, even when the places were liberating a considerable amount of methane.

As mining techniques progressed, it became more difficult to provide proper amounts of air to the face due to the width of the places being mined, the size of equipment being used and the higher rates of advances.

It is not uncommon in gaseous areas for the air used to ventilate the face areas to contain from 0.1 to 0.2 percent methane due to liberation from the coal already mined and the newly exposed area.

Continuous mining is being performed by several different kinds of equipment, the two most common being the ripper and boring types. Of the two, the boring type presents the more difficult problem because the borer develops the place to its own working width. In so doing, it blocks the immediate face area. The necessary bulk of the machine itself restricts the air flow over and around the machine (figure 1).

Machines of the type shown in figure 1 that can mine a place 6 by 12 ft are capable of advancing the place at the rate of from 18 to 24 in. per minute. This being the case, it is obvious as to the condition that will exist with respect to ventilation at the face if the area being mined liberates methane and an adequate amount of pure air is not supplied.

At the time continuous mining was introduced to the industry, an attempt was made to ventilate the face regions with a line canvas. All known methods of using canvas were tried and proved unsuccessful in keeping the methane content below the legal limits. Numerous stoppages in operations were required in order that pure air could slowly sweep out the accumulated gas.

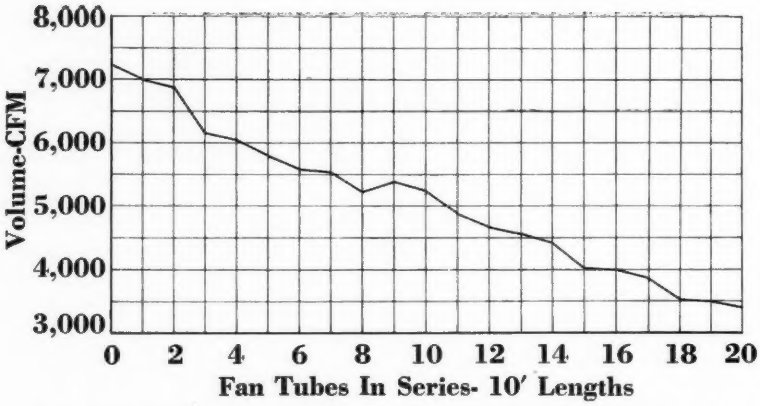


Fig. 2. Several methods of installing auxiliary fans and tubing are being tried by the coal industry. One test made outside the mine with a straight line of tubing involved an exhaust fan capable of producing 5000 cfm at 3.75 in. of water. Velocity readings were taken progressively at the inlet end of each ten-ft tube as it was attached. The flow chart shows the results. The average drop in volume for each ten ft of tubing is approximately 180 cfm

Auxiliary Fan Ventilation Tested

The only other method known was the possible use of auxiliary fan ventilation. This method is not permitted unless a special permit to use such equipment is granted by the Joint Industry Safety Committee. Such a permit was granted the U. S. Bureau of Mines in order that the auxiliary fan method could be tested, and tests were made in the O'Donnell No. 1 mine of Rochester & Pittsburgh Coal Co., located at Four States, Marion County, W. Va. Numerous mines are at the present time conducting tests under the Bureau of Mines Permit.

Results of the tests conducted in the O'Donnell mine were filed with the Joint Industry Safety Committee for their consideration. After due deliberation and study of reports, a permit was granted the O'Donnell mine to use such equipment, provided the following requirements were complied with:

1. The fan shall be of permissible type, maintained in permissible condition, so located as to avoid any recirculation of air, and inspected frequently by a qualified person when in use.

2. Fans operated blowing shall be installed in the positive intake air current, and the volume of such positive intake air current shall be greater than the maximum rated capacity of the fan.

3. Fans operated exhausting shall be installed in the return air current, and the volume of positive intake air current entering the place to be ventilated with exhaust fans shall be greater than the maximum rated capacity of the fan.

4. In places where exhausting auxiliary fans are used, accumulations of methane resulting from unschedule stoppage of the main fan shall be removed, after restoration of normal mine ventilation, by conducting the air current into the place with line brattice. Auxiliary fans shall not be operated in such place during stoppage of normal ventilation.

5. If the auxiliary fan fails, the electrical equipment in the place shall be stopped and the power disconnected until the fan is again in operation. During such stoppage, ventilation shall be by means of the primary air current conducted into the place in a manner to prevent accumulation of methane.

6. In places where auxiliary fans are used, the ventilation during scheduled idle periods (i.e. week-ends, idle shift, etc.) shall be by means of the primary air current conducted into the place in a manner to prevent accumulation of methane.

7. Electrical equipment shall not be operated inby the last open crosscut of any working place when the air therein contains more than 1.0 percent of methane.

8. The intake air current, the air passing through the fan, and the air in the immediate return from the working place shall not contain more than 1.0 percent methane.

9. In making examinations for methane with a flame safety lamp, the non-luminous "capping" flame shall be used.

10. Coal shall not be permitted to accumulate at the outby end of the miner conveyor to the extent that ventilation of the working place is restricted.

11. These requirements shall not be construed to supplant or negate any applicable provision of the Federal Coal Mine Safety Act or Federal Mine Safety Code.

As an added provision, an adequate number of tests for methane shall be made to insure compliance at all times with Requirement Nos. 7 and 8 listed above.

The company and the Bureau of Mines will continue their cooperation in the installation and operation of these auxiliary fans and the Committee is to be given adequate periodic reports on the progress of this work.

Exhaust Versus Forcing Method

Two different methods of ventilating the face region with the use of auxiliary fans are being tried by the coal industry. These two are the exhaust and forcing methods. Either method has its advantages and disadvantages. When the forcing or blower method is used, the air is delivered at a high velocity to the point of discharge, and this velocity causes relatively good diffusion. Furthermore, the air can be directed to areas where dead spots occur.

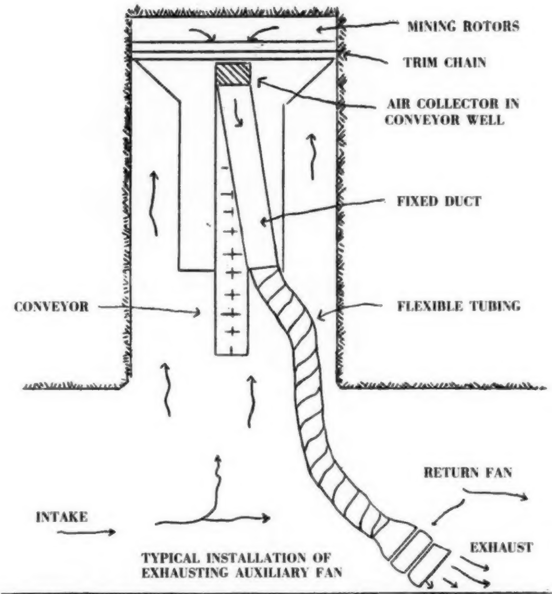
When the air is directed to the working face by the blowing method, it must return over the equipment and workmen. This, obviously, is not a good practice from a health, safety or productive standpoint.

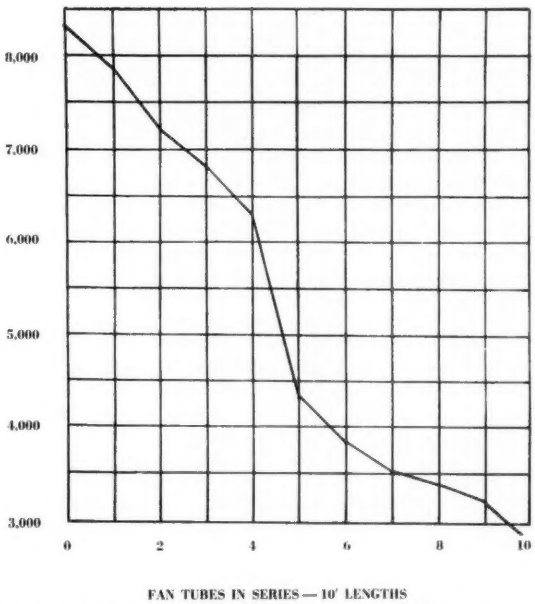
When the exhaust system is used, the intake air is taken to the inlet end of tube over the workmen and machinery and returned along with the dust which is produced in the process of mining, through the vent tubing and discharged into the return airways. Another advantage this method has is the area in which the operator has to perform his duties is much freer of dust particles.

Either method, with its increased quantity of air delivered to the working face, provides lower temperatures at the working face. Temperature readings were taken at the fan and at the operator's station and were 59° F and 62° F respectively. Readings taken when the canvas method was being used showed the temperature in the last intake crosscut to be 60° F and at the operator's station to be 82° F.

As a result of numerous dust counts, it has been determined that the number of dust particles per cubic foot attained near the operator by the suction method is only 60 percent of that which occurs in the forcing method.

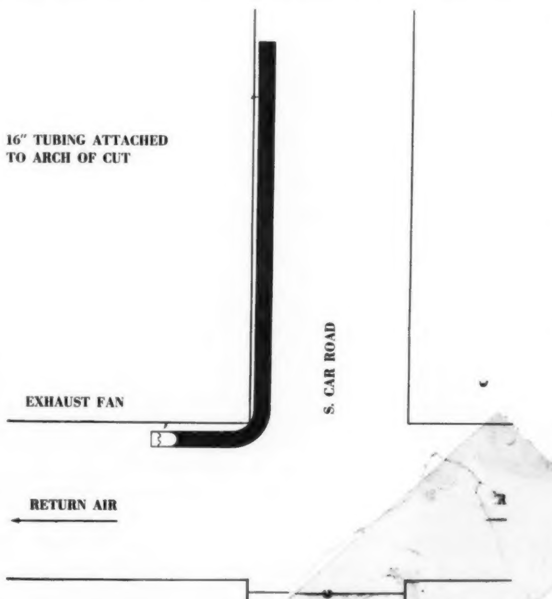
The entrained dust particles in the return from fan causes much concern. Various ways have been tried to trap the dust at the point of discharge. Among these are erecting canvas baffles in front of the discharge; using

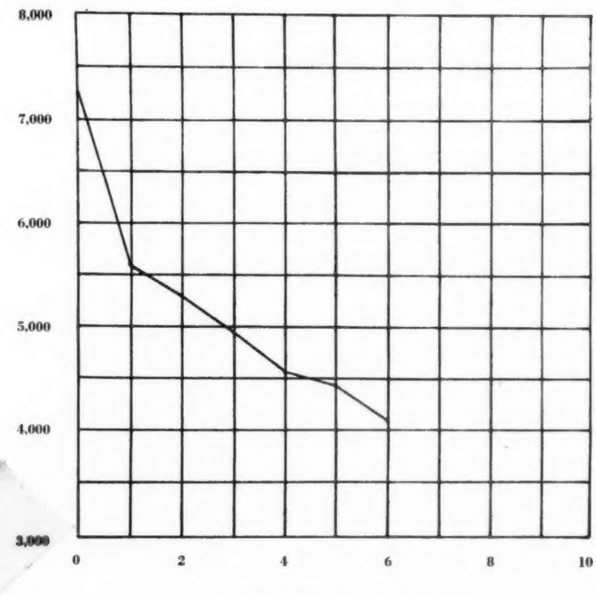




Figs. 3 and 4. (Left) Arrangement of fan and tubing for a test conducted inside the mine. (Right) Flow chart of test. In this arrangement the tubing is connected to the inlet side of fan and to a metal collector which is attached to the continuous miner. Intake air flows over and around the machine to enter the collector. The equipment used in conducting this test included an exhaust fan capable of producing 6000 cfm at 3.75 in. of water. Free flow was found to be 8325 cfm. The drop in volume of 2000 cfm after the fifth tube was attached was caused by a drop in d-c voltage, which slowed the speed of the fan. This points to the advantage of a-c power, which is more stable

a rock duster in conjunction with fan; adding additional fine mist sprays to the continuous miner and in the return air courses; and erecting air filters in front of the discharge of the fan. It was found that a considerable amount escaped and settled in the returns when any of the above methods were used. However, a method that was tried and proved more successful in trapping the dust involved using a water injection dust collector and fan, which served the dual purpose of providing air for the face and filtering the return air. This collector was driven by a 20-hp motor and required three to four gpm of water. Being a prototype model, it was designed to be mounted on the body of the continuous miner; however, due to insufficient head room, it





Figs. 5 and 6. (Left) Fan and tube arrangement used in a test and (right) flow chart of air volumes. Equipment used included an axial flow fan capable of producing 5000 cfm at 3.75 in. of water. The fan was set and the return tubing was attached to the fan and extended to a point beyond the operator on the opposite side to the controls. Additional tubes were attached progressively as the machine advanced, keeping the end of the tubing ahead of the operator at all times. Free flow was 7257 cfm

was placed in the first outby crosscut and tubes were attached to the inlet side and extended to a permanent collector mounted on the continuous miner. This provided adequate air volume and filtered the dust from the air but when in operation produced a high-pitched sound which made it physically uncomfortable to be around. It is hoped that this condition can be corrected since it has considerable merit in solving the dust problem.

Methods of Installing Fans & Tubing

Several methods of installing the fans and tubing are being tried by the industry. The following is a description and the results of some of these methods.

A 1½-hp, 12-in. diam blowing fan capable of producing 2600 cfm was installed on the intake side. Tubing 12 in. in diameter was extended from the fan for a distance of 100 ft to the rear of the continuous miner. When the tubing was as far as 35 ft from the face, there was sufficient air to keep the face clear with a methane liberation of 20 cfm. Although the face remained clear, a build-up in methane was recorded outby the face due to methane liberated from the newly mined coal and from the area already mined.

The next test was made on the outside of the mine with a straight line of tubing. The equipment used was an exhaust fan driven by a five-hp, 440-volt a-c motor capable of producing 5000 cfm at 3.75 in. of water. The velocity of the air was determined by the use of a velometer, and a ten-point traverse of the area was employed.

Velocity readings were taken progressively at the inlet end of each tube as it was attached. Figure 2 shows the flow chart of this test. The free flow was found to be 7250 cfm.

The average drop in volume for each ten ft of tubing is approximately 180 cfm. It is to be noted that this test was conducted under ideal conditions, good alignment, and tubing in good condition. Poor tubing and poor alignment materially affect the amount of air the fan delivers to the working face.

Figure 3 shows the arrangement of fan and tubing in the next test which was conducted inside the mine. Figure 4 shows the flow chart of the test.

Ft of Tubing	*Flow, cfm*
10	7,000
20	6,900
30	6,150
40	6,055
50	5,805
60	5,600
70	5,560
80	5,262
90	5,430
100	5,277
110	4,889
120	4,666
130	4,580
140	4,440
150	4,000
160	4,000
170	3,875
180	3,500
190	3,500
200	3,400
210	3,220
220	3,200
230	3,020
240	2,970

In this arrangement, the tubing is connected to the inlet side of fan and to a metal collector which is attached to the continuous miner and located in the throat of the conveyor well at a point eight ft outby the rotors. The collector is closed on all sides except the bottom which acts as the inlet to the collector. A piece of rubber belting is attached to the outby side of the collector and extends down to the conveyor of the machine. This was done to make a seal, thereby making the intake air flow over and around the machine to enter the collector. When coal is being carried on the conveyor, the belting rides the top of coal making at least a partial seal.

The equipment used in conducting this test was an exhaust fan driven by a five-hp, 250-volt d-c motor, capable of producing 6000 cfm at 3.75 in. of water. Spiral re-enforced 16-in. diam tubing in ten ft lengths was used. The free flow was found to be 8325 cfm.

Ft of Tubing	*Flow, cfm*	*Methane Liberation, cfm*
10	7,850	
20	7,200	
30	6,800	
40	6,300	6.80
50	4,300	5.16
60	3,800	5.70
70	3,500	6.30
80	3,400	6.80
90	3,200	8.00
100	2,800	8.40

The drop in volume of 2000 cfm after the fifth tube was attached was caused by a drop in the d-c voltage, which slowed the speed of fan. This points up the fact that a-c power is the more stable and should be used when possible with this method of ventilation. During this test operations were stopped on two different occasions due to a high methane concentration in the right hand corner of the face. Line canvas was installed to remove the methane.

Figure 5 shows the fan and tube arrangement used in the next test. Figure 6 shows the flow chart of air volumes.

Equipment used included an axial-flow fan capable of producing 5000 cfm at 3.75 in. of water; it was driven by a 5-hp, 440-volt a-c motor.

The fan was set and the return tubing was attached to the fan and extended to a point beyond the operator on the opposite side to the controls. Additional tubes were attached progressively as the machine advanced,

Ft of Tubing	*Flow, cfm*	*Methane Liberation, cfm*
10	5,547	
20	5,228	
30	4,920	
40	4,539	3.08
50	4,428	4.43
60	4,084	4.90

keeping the end of the tubing ahead of the operator at all times. Free flow was 7257 cfm.

Booster Fans Needed to Handle Methane

It is quite evident that the immediate face area cannot be ventilated properly with an auxiliary fan and tubing alone. As a needed aid in accomplishing this, booster fans are needed to keep methane content of the atmosphere at the immediate face below the requirements of the law.

When liberation of methane at the immediate face area and from the area already mined is greater than 40 cfm, multiple or larger fans should be used.

A-c power should be used for auxiliary fans when possible, thereby eliminating the possibility of volume changes due to voltage drops.

There is a need for a standard way of measuring the volume of air being delivered or returned through tubes when used to ventilate working places.

Three different tools can be used to measure the velocity of air current within the tubes, namely, the anomometer, a velometer, and the Pitot tube method. Different results were obtained from each method, indicating the necessity of a standard.

Geologic Reconnaissance of Large Areas

Each step in the development of a reconnaissance program must be adapted to the particular field conditions and geologic environment

By ERNEST E. THURLOW
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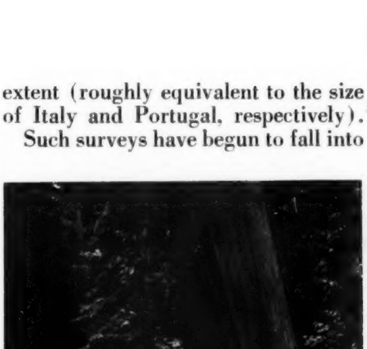
Northern Pacific Railway Co.

LARGE scale exploration for mineral deposits calls for the employment of the most up-to-date prospecting methods available, including the use of aerial photography, geophysical surveys, and geochemical prospecting. Specialists in these fields are required in increasing numbers but the foot soldier of geology, the field geologist, is not in danger of being entirely replaced by reconnaissance teams. However, new developments in photographic techniques, instrumentation, and theoretical considerations mean that this is an ever changing field and the challenge is great for progressive companies to be leaders in the search for raw materials for tomorrow's industries.

Extensive reconnaissance programs are being conducted on a grand scale in Canada, Africa, South America, Australia, the State of Alaska, and to a lesser extent the rest of the United States. As an example—the Anglo American Corp. of South Africa Ltd. and associated companies, operating under the name of Chartered Exploration, are investigating two concession areas in Northern Rhodesia and Tanganyika that are individually 120,000 and 34,000 square miles in extent (roughly equivalent to the size of Italy and Portugal, respectively).

Such surveys have begun to fall into a pattern of investigation that starts with obtaining as much information as possible through airborne procedures and techniques, including photography and geophysical methods followed by photography, geochemical prospecting, ground geophysical surveys, and physical exploration. The first objective is to determine the broad geologic features that will permit reconstruction of the geologic and tectonic history of the area. Theoretical considerations based on geologic facts will determine the priority of detailed investigations pointed toward discovery of economic orebodies.



Geochemical prospecting is being used by Northern Pacific to test stream sediments at a project in northwestern Montana involving an area of 2500 sq mi. Several known mineral deposits occur in the area

Northern Pacific Lands and Land Policies

Although this article is concerned with the general field of geologic reconnaissance of large areas leading to economic appraisal, it deals specifically with this type of program as it is being developed by and for the Northern Pacific Railway Co.

The approach to evaluating the mineral potential of company lands is somewhat different than would apply to a mining company or consulting group because of three rather unique factors concerning the land ownership and management. These are (a) a checkerboard pattern of land ownership, (b) the fact that the Land Grant Act precluded the government's granting of mineral lands other than those that might be coal or iron bearing, and (c) a desire to consolidate surface ownership through land exchanges for more efficient management.

Northern Pacific acquired a large amount of land under the Land Grant Act which was signed by Abraham Lincoln and became effective on July 2, 1864. By this act, Northern Pacific was granted the odd numbered sections for 20 miles on either side of the right of way through the States and 40 miles on either side through the Territories. (Only Oregon and Minnesota on opposite ends of the line were States).

The boundaries of this theoretical checkerboard strip were modified by mineral discoveries and homesteads, but ultimately the company received some 39,000,000 acres of the approximately 50,000,000 acres to which it was entitled by the Land Grant Act. Nearly 80 percent of this land has been sold or otherwise disposed of but the company still holds mineral rights on about 8,500,000 acres, of which approximately 2,300,000 acres are owned in fee.

Results of Company Investigations Available

Although the government placed restrictions on the granting of mineral lands, the geology of the region was not well known and present ownership includes several areas that have mineral potential of some promise. Northern Pacific is interested in evaluating these areas with particular emphasis on its own lands, whereas a mining company would consider each area as a unit and probably would obtain options before starting its field investigations.

A further point that may be a determining factor in how far we carry our economic appraisal is our general policy of leasing mineral lands to companies or individuals for prospecting, exploration, and development. This does not rule out the possibility of operating our own mines if conditions warrant, but this appears to be only a remote possibility at the present time. However, because of this policy, we ordinarily make available to interested companies the results of our investigations.

The final consideration is that Northern Pacific, other private companies, and the U.S. Forest Service are interested in blocking up forest lands through exchange agreements with or without the conveyance of mineral rights. In these exchanges, the geology division is called upon to evaluate the mineral potential of fairly large areas where we have substantial ownership as well as examining scattered parcels of our lands. Government agencies are not permitted to exchange fee title where known or suspected mineral deposits (including oil and gas) may exist on Federal lands. Nor are private companies ordinarily interested in relinquishing lands with reasonable mineral potential.

Known mineral potential, then, is not the sole factor that we must consider in selecting an area for geologic reconnaissance nor in defining the limits of the area to be examined. It is based on a combination of factors including mineral potential, ownership, traffic potential, and land management.

With this background information, we may now proceed to the program that is being developed for mineral evaluation of large areas where Northern Pacific has substantial ownership.

Geologic Reconnaissance Program

Figure 1 is an outline of the program we are following in our northwest Montana project which involves an area of about 2500 square miles lying between Flathead Lake and the Idaho state line. This area was scheduled for possible land exchange and meets in a general way the specifications outlined in the previous section. Northern Pacific owns approximately $12\frac{1}{2}$ percent of the acreage and there are several known mineral deposits in the area.

The first step is self explanatory and has no unusual features in its application to this project. It was found in step two that government photographs on a scale of 1:40,000 were available for only about one-third of the area. Northern Pacific had its own aerial photographs at a scale of 1:12,000 that were made up for forest inventory purposes, but this was not a satisfactory scale for the intended use and the remaining area was photographed under contract by Mark Hurd and Associates of Minneapolis.

1. Search of literature, maps, aerial photographs.
2. Obtain good aerial photographic coverage of entire project area.
3. Preparation of reconnaissance photogeologic map.
   (a) Photo mapping—field checks, etc.
   (b) Base map.
   (c) Compilation and interpretation of final map.
4. Establishment of base of operation for field parties.
5. Development of geochemical prospecting program.
6. Evaluation and detailed follow-up of geochemical anomalies.
7. Ground geophysical surveys.
8. Physical exploration and evaluation.

Fig. 1. Stages of development in a geologic reconnaissance program

Since the company had no photogeologist at the time the project was started, E. J. Longyear Co. of Minneapolis was retained to do the photogeology. Longyear personnel produced a photogrammetric base map and made preliminary photogeologic interpretations on the photos. A few days reconnaissance checking in the project area sufficed to identify rock units, structures, and unusual features on the photos. The photogeologic map was then prepared by combining the base map and the geology from the photos. The study was concluded with a brief field check and a short written report.

Step four is highly important but will depend entirely on local conditions. The base of operations should be as centrally located as possible consistent with the best available services. The town of Libby was selected as the main base and a motel room with kitchen facilities served as a laboratory and field office.

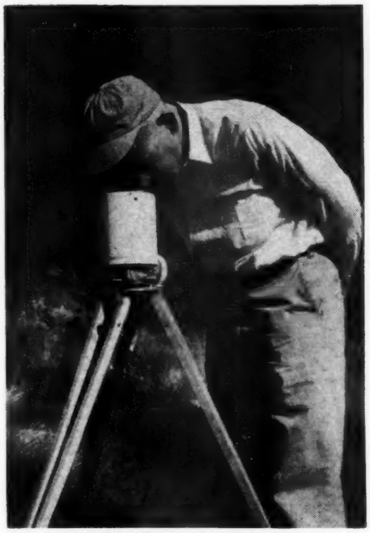
Geochemical Prospecting

Extensive soil and vegetation cover in the area plus the fact that a well developed stream drainage pattern existed were among the factors which indicated that geochemical prospecting should be thoroughly investigated.

A geochemical prospecting program based on sampling of stream sediments was set up in two stages to be applied to sub-areas or blocks. The blocks generally represented good railway ownership coincident with photo-interpreted structural anomalies, intrusives, or other possibly favorable geologic features. Stage one sampling had no regular spacing but was a check of major peripheral or axial streams of each block and of the tributaries to these main streams at the point of confluence. Ultimate sample spacing of all drainages was standardized at one-quarter of a mile in stage two, based on a test traverse across a known mineralized zone.

The first stream sediments collected were tested for readily soluble metals by the cold ammonium citrate extraction and dithizone colorimetric observation. The results were completely negative for reasons as yet undetermined. Because of this and the need for positive information on proper sample spacing, several test traverses were laid out across known vein deposits, and two types of samples were collected at each sample locality along the traverses.

The first sample was panned and separated into a magnetic and a nonmagnetic fraction. It had been determined by other groups working with stream sediments that magnetite in some manner is able to acquire heavy metal ions from solution and will release them by fusion and hot acid extraction. Nothing has been published on just how or at what stage of mineralization or alteration the magnetite becomes charged with metallic ions. The results of the tests on these two fractions were positive but erratic and were considered unreliable. The second sample was a regular stream sediment type that was also treated by fusion and hot hydrochloric acid extraction and this proved to be satisfactory with reproducible results. Tests were made for total heavy metals with dithizone and results were expressed in zinc equivalent units. Values to date have ranged from 50 to 400 ppm with a threshold of about 300 ppm. It is readily apparent that



Magnetometer traverses aid interpretation of concealed geologic features

no real anomalies for heavy metals have as yet been detected.

It should be mentioned that the nonmagnetic fractions of the panned concentrates were also checked for scheelite with an ultraviolet lamp though the results, again, were negative. Scheelite is fairly common in known mineral deposits of the region otherwise chemical tests for tungsten would have been applied to the nonmagnetic fraction.

Spectrographic Analyses Support Searches

A few samples from each geologic environment are selected for spectrographic analysis to minimize the chance of overlooking valuable deposits of minerals such as those containing beryllium, rare earths, etc., which would not be detected in the geochemical tests.

Although no new ore bodies have been found in our preliminary investigations of the area we are consoled by the fact that the project was not initiated in the blocks of greatest potential but rather where it was anticipated that lands could be relinquished in an exchange agreement. It is felt that the right geochemical prospecting approach for this particular area has been developed and can be applied to the remaining land to be investigated.

If and when geochemical anomalies of significance are detected, their delineation may be accomplished by offset sampling and analysis using the same technique as originally employed or some other suitable technique. Depending upon local conditions it may be advisable to change from stream sediments to soil sampling or possibly geobotanical sampling or a combination of these. The results of all geochemical samples should be carefully plotted on a comprehensive geochemical map for final evaluation of their significance.

After careful sampling and geologic mapping have determined as closely as possible the geologic environment of an unexposed orebody, a geophysical survey may be indicated, particularly if the target appears to be large and diffused. Selection of a geophysical survey method will depend upon a careful analysis of all of the geologic and geochemical data available, but its application may save costly dollars in physical exploration.

"Yardsticks" For Estimating Costs

An attempt at arriving at unit cost data for any particular phase of this type of program must bear so many qualifications as to render it almost inapplicable even to a fairly similar project. However, there are two costs which were found to be fairly easy to determine and are very important to the overall cost in this case. The first is the square mile cost of aerial photographic coverage and photogeologic interpretation, and the second is the direct field cost of stream sediment sampling also on a square mile basis. They are as follows:

Photogeology		*Cost per square mile*
Aerial photographs		$ 2.26
Photogeologic interpretation		5.94
Finished photogeologic map	Total	$ 8.20
Geochemical Prospecting		
Direct field cost in selecting sample localities, collecting, and analyzing stream sediment samples in 83 sq mi block		$13.48

Either of these unit costs could vary widely from one company to the next depending upon the project area involved, mode of operation, and overhead charges. However, this may provide a yardstick of sorts for estimating costs for this type of program.

Another factor to consider in estimating costs is the time element. It has been estimated that the photogeologic map can be produced seven to ten times faster in terms of man days than a comparable reconnaissance geologic map prepared from mapping on aerial photographs in the field and at a somewhat lower (perhaps 20 percent) cost.

As we have had no geophysical surveys made on this scale of operation, cost data for this phase are lacking.

Field assistant making colorimetric determination at a motel base camp laboratory

Overall costs for geologic reconnaissance projects will vary widely depending upon the emphasis and the amount of effort placed on each step.

Adapt Each Step to Conditions

The approach to geologic reconnaissance of large areas leading to economic appraisal that is outlined here permits a rapid and comparatively economic method of evaluation. Each step in the development of such a program must be adapted to the particular field conditions and geologic environment encountered. Field research may be necessary to assure that the best method of geochemical prospecting or geophysical surveying is undertaken. The photogeologic map should be continuously checked in the course of all field studies to improve its accuracy and usefulness.

If reconnaissance investigations lead to positive target areas, detailed geologic mapping and sampling of these areas should indicate the type of additional exploration to be recommended.

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Fig. 1. Chart depicts progress in propelling the wheel

HOW SHALL WE TURN the WHEELS?

A progress report on the use of electric drives for wheels

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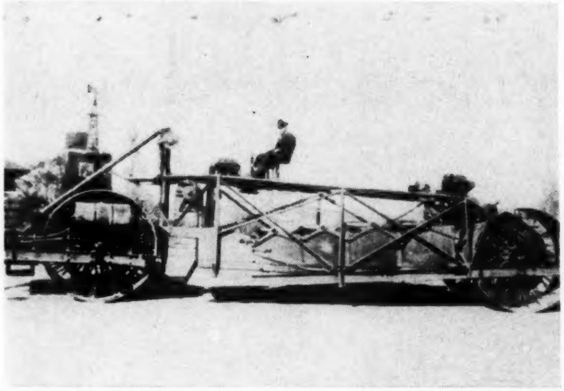
WHEELS are not to be obsoleted for quite some time to come in spite of the advent of atomic power and its many uses. This presentation is intended to be more or less a report of progress rather than an answer to the problem of "How Shall We Turn the Wheels?" It will touch upon three chief points as follows:

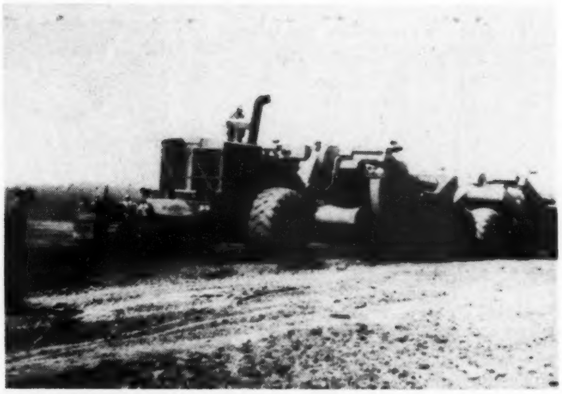
1. **A brief history of the wheel and the power as applied to it.**
2. **Progress in propelling wheels for heavy units.**
3. **Understanding of the requirements for propelling wheels and a view of future powered wheels.**

Wheel Made Its Appearance Around 3500 B.C.

A brief historical account regarding the wheel would appear to be as follows. It is indeed a rather ancient device apparently making its appearance first in the Bronze Age around 3500 B.C., probably originating for use on carts in Mesopotamia or Near Asia. The development of the wheel followed the use of rollers which were already in existence for moving heavy objects.

Various excavations of ancient ruins indicate two and four-wheeled chariots were found in Kish in Mesopotamia (now known as Iraq). This appeared to be around 3500 B.C. The wheels found in excavations were rather complex in their body construction, indicating a rather long prior art in this development. Apparently these wheels were used on various carts or carriages to convey royal corpses to their tombs, or were em-





Figs. 2 and 3. The old and the new. (Left) R. G. LeTourneau's first electric propelled scraper, built in the early twenties, and (right) one of his latest heavy earth hauling units

ployed in other forms for use in engines of war.

These early wheels were all made of wooden planks, generally tripartite discs. Spoked wheels must have been developed around 2000 B.C., and also showed up in the excavations in Mesopotamia, Central Turkey and Persia. Perhaps there was some considerable connection between the use of the horse as a draught animal and the use of the spoked wheel—due to the speed with which a horse could travel in contrast to the oxen which were pulling the carts equipped with the solid disc wheel.

It is of further interest to note that the wheel appeared in Britain about 500 B.C. Leonardo daVinci conceived concepts of power driven vehicles as early as the 15th Century. Newton proposed steam carriages in or about 1680. Nicolas Cugonot, a Frenchman, around 1769 built a three-wheeled carriage with a steam power plant operating on a single front wheel. Reports indicate this unit would travel at a maximum speed of 2.5 mph.

In 1825 the first really successful steam locomotive was placed in service in England. During the next five years engineers increased their interest in internal combustion engines, but approximately 50 years of development followed this before a really efficient vehicle powered with an internal combustion engine, rather than steam, came into being. Steam, electric motors and batteries, as well as the internal combustion engine were available between 1875 and 1890. Records indicate, however, that it was around 1900 before any degree of success was achieved in building self-propelled road vehicles of a practical nature.

Locomotives continued to be powered with steam for all overland or long distance runs. In the early 30's, about 1934, the diesel electric locomotive began to replace steam and progress in this direction has been increasing rather steadily, especially in the last two decades.

The interest in propelling each wheel of a motor car was apparently first exploited by Mercedes-Benz in 1905 and 1906 when they built a few vehicles with an electric motor in each wheel. Indications are that production was discontinued for reasons of weight, cost and dependability.

Somewhere around the early 1900's, there was a truck which used one motor to drive the rear axle. There was a planetary reduction in each wheel and the differential action was taken between the motor pinion and the cross shaft through the axle housing to the planetary. Again for reasons mentioned, this was abandoned.

During World War I, perhaps between 1917 and 1918, the Big Bertha cannons were equipped with d-c electric drive with ten driving wheels. Speeds were reported as high as ten mph. In all instances it seems a most desirable characteristic was achieved in that the flow of power to these drives was extremely smooth and control was in very fine increments.

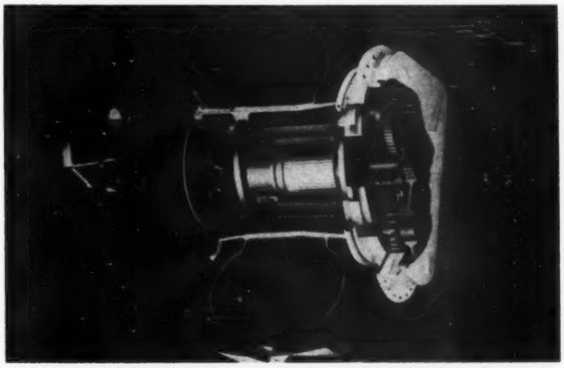


Fig. 4. Cross section of General Electric Company's electric wheel

Fig. 5. A 55-ton ore hauler built by Unit Rig & Equipment Co. has a 700-hp engine turning the generator which supplies the power to the wheels

Progress in Propelling the Wheel Accelerated After 1920

The accompanying historical chart (figure 1), starting back at 3500 B.C. and drawn up-to-date, shows the relatively slow progress that was made over the centuries. Considerable activity starts around 1900 with an extremely rapid acceleration from 1920 on. The writer believes that had there been a man of courage, of vision and daring such as R. G. LeTourneau back in those early times, the curve would have taken quite a different shape. LeTourneau should justly receive considerable credit for envisioning the desirability of putting the power into each wheel for an all-wheel drive in hauling units such as self-propelled scrapers.

One of the first self-propelled scrapers (figure 2), with all-wheel drive, was built in the early '20's by R. G. LeTourneau. It self-loaded and transported at speed up to five or six mph. One of LeTourneau's latest contributions (figure 3) to the art, using electrically driven all-wheel drive in a heavy earth hauling unit, also self-loads and is reported to reach speeds as high as 12 to 14 mph.

General Electric Co. is another manufacturer that has done a great deal of research and development work and figure 4 shows a most noteworthy development of the electric wheel. The cross section pictured shows the general arrangement of the d-c motor, its planetary reduction, etc., built into the wheel.

Figure 5 shows a giant new ore hauler built by Unit Rig & Equipment Co. of Tulsa. With a payload capacity of 55 tons, this unit has a 700-hp engine turning the generator which supplies the power to the wheels and other controls as necessary. Each wheel has one of the General Electric motors shown in figure 4. It is reported that this unit has a variable drive which eliminates the steps in speed ratios as is common with conventional transmissions. The motors provide dynamic braking by using them as generators. Considerable effort was made to make the control of a conventional nature for further safety of operation. It was felt this reduced confusion in the mind of the operator.

Some General Electric concepts that are of considerable interest are shown in figure 6. It gives a general idea of the kind and type of heavy equipment to which electric wheel propulsion could be adapted. Undoubtedly some of these will be placed in iron ore operations in the near future.

Figure 7 shows a coal hauler being

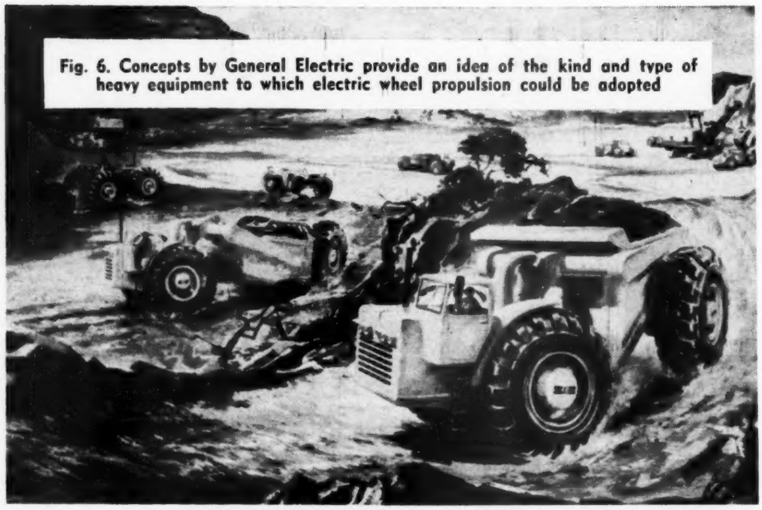


Fig. 6. Concepts by General Electric provide an idea of the kind and type of heavy equipment to which electric wheel propulsion could be adopted

Fig. 7. A 600-hp LW-80 truck used by Peabody Coal Co.

Fig. 8. A 32-ton rear dump truck that employs only four grease fittings

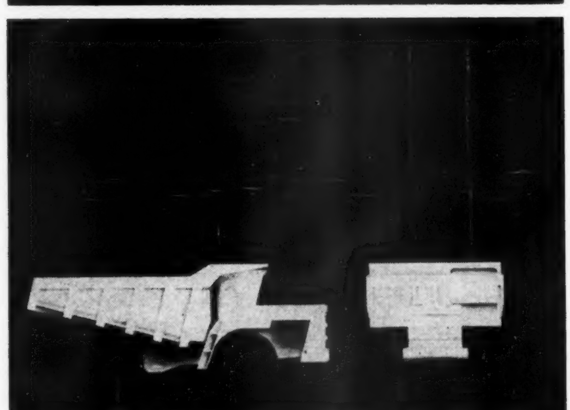


Fig. 9. Concept drawing of a 55-ton rear dump unit currently being built

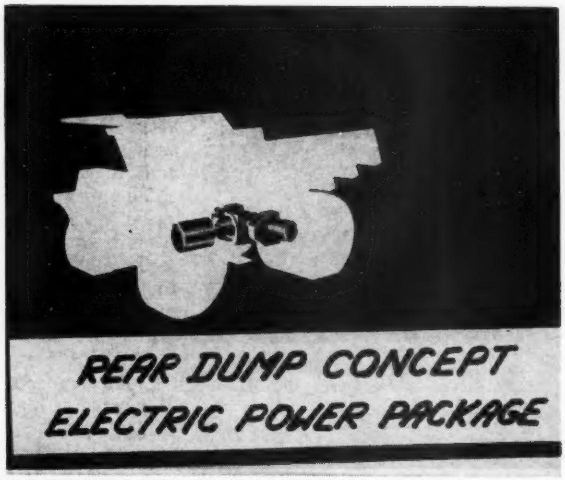


Fig. 10. (Left) LW rear dump concept—electrically driven. Note the shortening of the vehicle from the one shown in figure 9. (Right) Fig. 11. Electrical power package for rear dump truck shown in figure 10

used by Peabody Coal Co. One of LeTourneau-Westinghouse's current production units, it is powered with a 600-hp motor and can travel at speeds up to 40 mph. The unit weighs 74,400 lb empty and grosses out on the average at 236,000 lb. This unit gives the manufacturer a good base line for its electric drive work. Related to weight, speeds, production, sales and operating costs, component service, life and dependability can be measured rather accurately also.

One of this manufacturer's current 32-ton rear dump trucks is pictured in figure 8. This standard production unit employs Hydrair suspension—for easier ride of load and operator—short turning radius, low center of gravity, ease of component serviceability, and only four grease fittings.

Figure 9 is the concept drawing of LW's 55-ton rear dump unit currently being built in the factory. This unit is powered with a 600-hp engine, has an empty weight of 62,000 lb and a gross weight of 172,000 lb. It employs the same features as the rest of the truck line and adds a few additional ones.

A unit currently under study (figure 10) is expected to use a 600-hp gas turbine driving a generator. From the configuration you can note the shortening of the vehicle from the previous figure. In many operations this has considerable significance.

Figure 11 shows the general arrangement of the drive. Only a small departure from the company's conventional drive is anticipated here, because management reasons it is best to design by evolution rather than

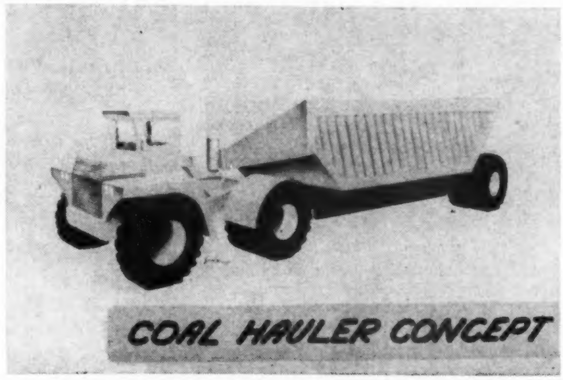


Fig. 12. A coal hauler concept under study is expected to embody the use of a 1200-hp gas turbine propelling a generator

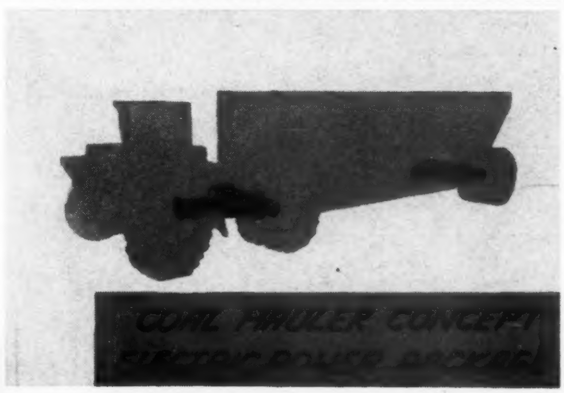


Fig. 13. Electric power package for coal hauler shown in figure 12

Fig. 14. A 150-ton coal hauler concept

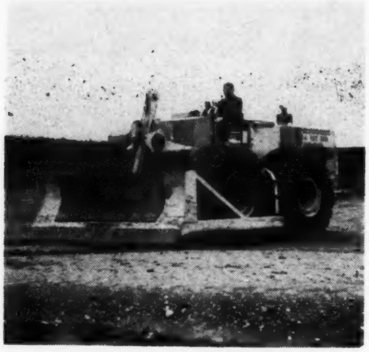


Fig. 15. A rubber-tired tractor which is fully powered electrically

Fig. 16. C Assist is one of a series of LW test units which uses a part-time a-c electric drive on the trailing unit, still retaining the conventional drive all the time on the front wheels

revolution when possible.

Another LW unit currently under study (figure 12) is expected to embody the use of a 1200-hp gas turbine propelling a generator. The tractor itself is somewhat shorter than the previous one and again this appears to have appreciable value.

The general arrangement of the drive with which the company expects to propel the trailer wheels as well as the rear tractor ones is shown in figure 13. This should give good mobility over rather poor ground conditions. With adequate power of somewhere in excess of 1000 hp, the company expects to propel the unit at a speed as high as road conditions will permit. Due to the Hydrair suspension, which permits the load to ride more comfortably with less frame and tire stress, it is believed higher transport speed may be achieved with success. This has proven to be the case with the production units in the field, with the chief limitation being power to propel them at higher travel speeds.

Figure 14 illustrates a 150-ton coal hauler concept. LW expects to propel the tandem trailer axles with units as shown in the previous figure.

Figure 15 shows the company's large rubber-tired tractor which is fully powered electrically, using a-c motors in arrangement to permit a multiplicity of speeds. This unit has been under test and has done a phenomenal job. The efficiency with which diesel power is converted into electrical energy at the drawbar is excellent. The response to control, as well as the control itself, exceeded company expectations. Simplicity is achieved through the lack of use of conventional clutches and brakes for steering. Full drive at varying speeds to the wheels is easily accomplished.

One of a series of test units (figure 16) that are in the field uses a part-time a-c- electric drive on the trailing unit, still retaining the conventional drive all the time on the front wheels. Experience indicates that at low speeds in bad soil conditions, or during the loading operation, traction on all wheels is highly desirable. Because of horsepower limitations, at higher travel speeds there is little benefit in propelling all wheels. The part-time arrangement permits LW to achieve the objective by putting the rear wheels to work only when it is necessary to do so.

Fig. 17. The Army Goer

Fig. 18. Hydraulic power wheel concept is expected to eliminate gears entirely

The much talked about Army Goer (figure 17) developed by LeTourneau-Westinghouse for Army Ordnance embodies the principle of part-time all-wheel drive in essentially the same manner as the preceding unit. This unit may be had in one or more speeds for the rear assist depending upon the requirements. It uses a-c.

Further simplification by the hydraulic power wheel (figure 18) is expected to eliminate gears entirely. Greater latitude is provided the designer by power package wheels. Engine power pump may be mounted as a unit in the most appropriate place for the vehicle under consideration. Frameless units with lower weight may become more practical. Unfortunately a cross section of this self-contained power wheel cannot be shown at this time for patent reasons.

The Problem Is One of Many Facets

There is a strong feeling in regard to electric power in each wheel but shall it be d-c or a-c? Many desirable features are readily achieved with d-c but experimental work indicates that a-c may well be the real compromise for which the user is really looking. Certain control developments underway indicate automatic speed changes are practical with multi-speed a-c motors. Developments now achieved permit running out of synchronous speed continuously at rather wide speed ranges and at constant torque levels. Tests also indicate that the air need not be filtered as fine for a-c generators and motors as for d-c. In fact, one manufacturer does not filter the a-c units at all. This may be of practical significance in many ways and for many reasons.

One of the prime deterents to the ability to haul more material per hour probably rests in the area of adequate and dependable horsepower. Therefore, manufacturers are looking very closely at new developments in piston engines and more especially in gas turbines. Fuel cells are also under

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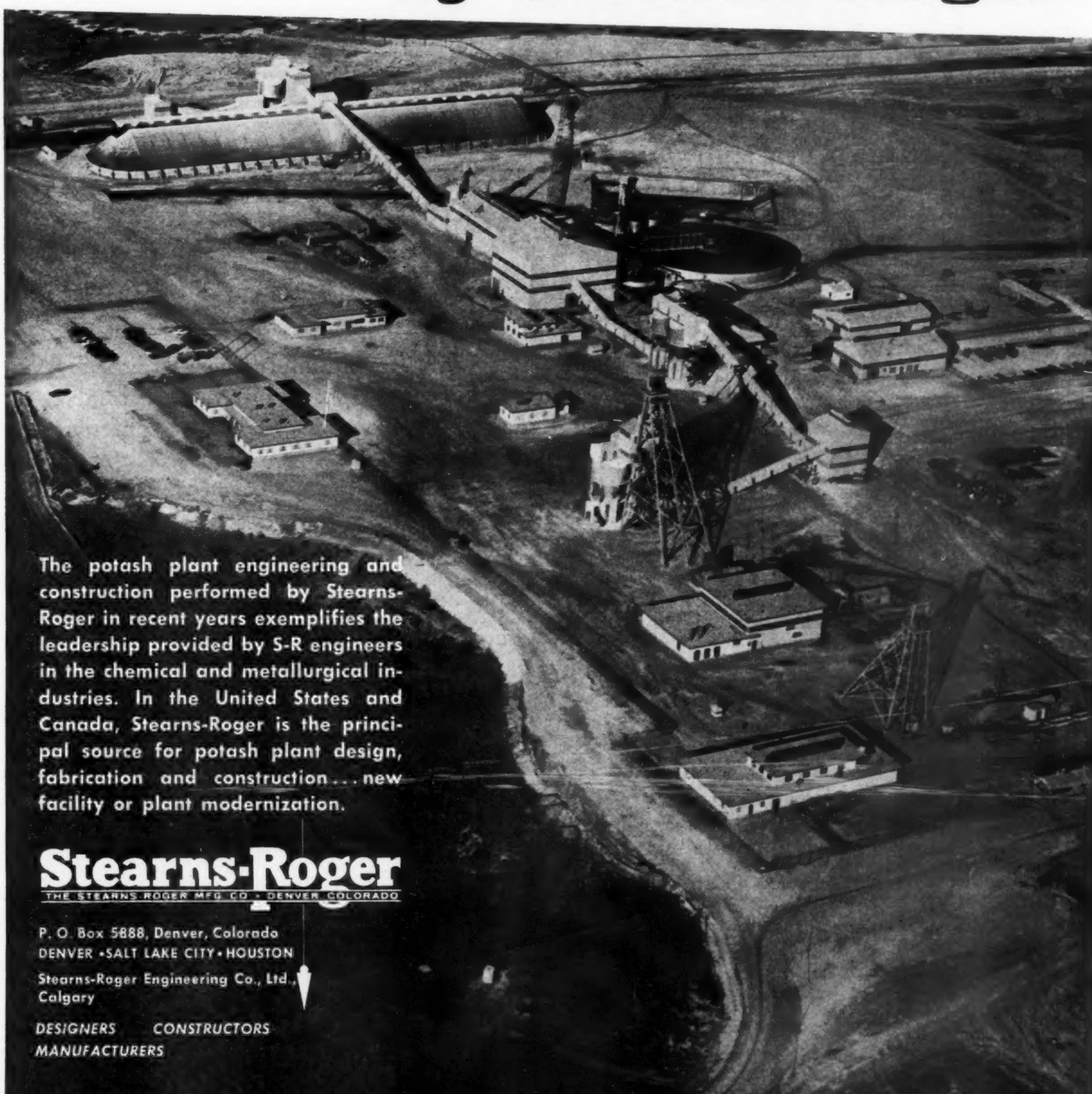
processing plants

for potash

by Stearns-Roger



ALL MINING MEN and MINING EQUIPMENT MANUFACTURERS are invited to attend a SPECIAL CONFERENCE ON

RADIOISOTOPES IN THE MINING INDUSTRY

Dr. Glenn T. Seaborg, Chairman of the U. S. Atomic Energy Commission, will speak at the Radioisotopes Luncheon during the Conference

Sponsored by the American Mining Congress and the Colorado School of Mines Research Foundation, in cooperation with the Office of Isotopes Development of the U. S. Atomic Energy Commission

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Following a highly successful AMC Conference on Radioisotopes in the Coal Industry in Pittsburgh last November, various members of the "hard rock" mining industry urged that a similar conference be held in Denver, to make this important information broadly available to mining men and mining equipment manufacturers in the West and throughout the metal and non-metallic mining industries. The result is the April 13-14 Conference.

Radioisotopes are finding increased application as a means of improving efficiency and cutting costs in mineral production and equipment manufacturing, and the entire mining industry can benefit from their use.

BROWN PALACE HOTEL

Denver, Colorado

APRIL 13, 14 1961

The great variety of radioisotope uses can be divided in three broad classes—(1) tracer atoms; (2) measurement by radiation, and (3) high intensity radiation. Tracer atoms, because they can be detected in minute quantities, prove a versatile tool in making liquid flow studies and measuring mechanical wear. Measurement by radiation makes possible, through the use of a great variety of nuclear gauges, rapid inspection for flaws in forged or welded parts, precise measurement of metal thickness in metal forming operations, and continuous measurement of density or levels in process control. With high intensity radiation it is possible to alter the properties of various materials or initiate chemical reactions.

(Continued on page 44)

CONFERENCE PROGRAM

BROWN PALACE HOTEL, DENVER, COLORADO

APRIL 13-14, 1961

All Technical Sessions will be held in the Ballroom of the Brown Palace Hotel; the Luncheon on Friday will be in the Silver Glade of the Cosmopolitan Hotel.

Thursday, April 13

9:00 A. M.—REGISTRATION—MEZZANINE

10:00 A.M.—WHAT RADIOISOTOPES CAN MEAN TO THE MINING INDUSTRY

Opening of Conference
JULIAN D. CONOVER, Exec. Vice Pres., American Mining Congress, Washington, D. C.

CHAIRMAN: E. H. CRABTREE, Dir., Colorado School of Mines Research Foundation, Inc., Golden, Colo.

Radioisotopes—Profitable New Tools for Industry
PAUL C. AEBERSOLD, Dir., Office of Isotopes Development, Atomic Energy Commission, Washington, D. C.

Implications of Radioisotopes to the Mining Industry
HAROLD J. ROSE, Consultant, Pittsburgh, Pa.

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2:00 P.M.—RADIOISOTOPES IN GEOLOGY, GEOCHEMISTRY, CHEMISTRY, AND MINERAL PROCESSING RESEARCH

CHAIRMAN: E. I. RENOUARD, Vice Pres., Western Operations, The Anaconda Company, Butte, Mont.

Radioisotope Applications at Kennecott
W. M. TUDDENHAM, Head of Analytical Services & Special Studies, and HENRY W. FRANZ, Project Engr., Western Mining Divisions' Research Center, Kennecott Copper Corp., Salt Lake City

Borehole Applications of Radioisotopes
A. H. ROEBUCK, Asst. Mgr., and R. G. LOPER, Supv. of Logging Technology, Westco Research, The Western Co., Ft. Worth, Tex.

Geochemical Applications
J. KENT PERRY, Geol. Engr., Colorado School of Mines Research Foundation, Inc., Golden, Colo.

Radioactivity Dating of Major Earth Structures
SAMUEL S. GOLDICH, Chief of Isotope Geology, U. S. Geological Survey, Washington, D. C.

Radiophysics in Mineral Identification
Speaker to be announced

* * *

4:30 to 6:30 P.M.—RECEPTION

Brown Palace Hotel—location will be announced at the session

All registrants invited—Compliments of American Mining Congress

Friday, April 14

9:00 A.M.—REGISTRATION

9:30 A.M.—RADIOISOTOPE APPLICATIONS IN MINERAL PROCESSING

CHAIRMAN: ROBERT HENDERSON, Vice Pres., Western Operations, Climax Molybdenum Co., Golden, Colo.

Application of Nuclear Density Gauges in the Mining Industry
PHILIP E. OHMART, Pres., The Ohmart Co., Cincinnati

Radioisotope Applications in Iron Ore Processing
HENRY P. WHALEY, Mill Supt., Erie Mining Co., Hoyt Lakes, Minn.

Principles and Operation of Density/Moisture Gauges
O. K. NEVILLE, Vice Pres., Nuclear-Chicago Corp., Chicago

Radioisotopes in Ore Concentration Studies
A. M. GAUDIN, Professor of Mineral Engrg., Massachusetts Institute of Technology, Cambridge, Mass.

Summary of Applications in Process Control
JAMES GARY, Head, Petroleum Refining Dept., Colorado School of Mines Research Foundation, Inc., Golden, Colo.

12:15 P.M.—RADIOISOTOPES LUNCHEON

PRESIDING: ROBERT M. HARDY, JR., Pres., Sunshine Mining Co., Spokane; Chairman, Western Division, American Mining Congress

Greetings from HON. STEPHEN L. R. MCNICHOLS, Governor of Colorado

GUEST SPEAKER: DR. GLENN T. SEABORG, Chairman, U. S. Atomic Energy Commission, Washington, D. C.

2:00 P.M.—APPLICATIONS IN QUALITY CONTROL, MAINTENANCE AND TESTING

CHAIRMAN: ALBERT E. SEEP, Pres., The Mine & Smelter Supply Co., Denver

Radiography in Maintenance
RAY MCBRIAN, Dir. of Research, The Denver & Rio Grande Western Railroad Co., Denver

Radiography in the Fabrication and Manufacture of Critical Equipment
WALTER B. HESTER, Dir. of Engrg., Stearns-Roger Manufacturing Co., Denver

Measuring Wear in Pipelines
T. R. YOUNG, Asst. Mgr., Mining Div., Colorado School of Mines Research Foundation, Inc., Golden, Colo.

Training for Industrial Applications of Radioisotopes
PAUL J. BLAETUS, Chief, Isotope Technology Branch, Office of Isotopes Development, Atomic Energy Commission, Washington, D. C.

Radioisotopes Can Serve the Mining Industry in Many Ways. Thus . . .

- By incorporating suitable nuclear instruments, which are not costly, into a process-control system, it is possible to automate many operations that are now manually controlled—a matter of prime interest to mill men.
- Gamma radiography has provided a nondestructive testing tool which can detect flaws in steel more than a foot thick—of special benefit to equipment manufacturers and maintenance men.
- Borehole logging and correlation of geologic structures with radioisotopes is receiving increasing attention and holds promise of being an important aid in geology and geochemistry.

Speakers at the two-day Conference will include representatives of the Office of Isotopes Development of AEC, together with mine operators and equipment manufacturers who have had experience with radioisotopes. They will discuss present uses and consider potential areas of application for this valuable new tool.

Uranium producers are particularly urged to attend the Conference. Not only will they learn about the potential of radioisotopes in their own operations, but they will be deeply interested in the extent to which their product is finding acceptance in a wide range of industrial uses.

The four technical sessions will be held in the Ballroom of the Brown Palace Hotel. Thursday afternoon, April 13, a reception and cocktail party will be given by the American Mining Congress for Conference speakers and those attending the meeting.

At the Radioisotopes Luncheon on Friday, April 14, Dr. Glenn T. Seaborg, new Chairman of the U. S. Atomic Energy Commission, will make his first appearance before a mining audience. Formerly Chancellor of the University of California, Dr. Seaborg has had a distinguished career in nuclear science which earned him the Nobel Prize in Chemistry in 1951 and AEC's coveted Enrico Fermi Award in 1959. His address will point up the potential uses of radioisotopes and will also cover the broad field of uranium problems as he sees them.

The Special Conference on Radioisotopes in the Mining Industry can show the way to cost-cutting in exploration, mineral beneficiation, equipment maintenance, manufacturing, and many other fields.

Hotel reservations may be made directly with the Brown Palace mentioning your attendance at the Conference. Write directly to the American Mining Congress for advance registration and to order tickets for the Radioisotopes Luncheon at $3.50 each.

Make your plans now to attend. You can't afford to miss it!

AMERICAN MINING CONGRESS

Ring Building, Washington 6, D. C.

Radioactive Pickup for Automatic Control of Mining Machinery*

By V. G. SEGALIN and A. A. RUDANOVSKY

The first in a series of original translations covering research in the mining field by Russian scientists

AUTOMATION of mining machines is a prerequisite for modern mining—that is, mining without the use of men at the face.

In order to automate mining machines, it is first necessary to develop devices capable of controlling the machine's position in the coal seam. In a number of cases such devices may also be adapted to existing machinery and thereby improve performance and save labor. This would mean, for example, that it would be possible to prevent leaving excessively large barriers, or to prevent cutting into top or bottom.

Work on the development of a device using radioactive radiations is being conducted in the Automation Laboratory of the Mining Institute of the Soviet Academy of Sciences. The inclusion of such a device into the automatic control system of a universal cutting machine may be envisaged in the following way: A radioactive sensing device reacts to the position of the cutter bar in relation to the "coal-rock" contact. The sensing device puts out an electrical signal, the magnitude of which is proportioned to the distance of the cutter bar from the contact, while polarity is determined by the direction of deflection. The signal is amplified and delivered to a servomechanism which returns the bar to the desired position.

Discussed below are the initial results of research work on the creation of a radioactive sensing device—the basic element of the automatic control system referred to above.

The action of the radioactive pickup is based on Compton's effect of gamma-ray scattering. If other definite conditions are met, this phenomenon plays a more important role than other effects of gamma-ray interaction with the substance. The intensity of gamma-radiation scattering is proportional to the density of the medium. In the case of a two-layer medium, each having different densities, it is proportional to the volume ratio of these media in the total volume of the scatterer, or, in the final analysis, to the distance from the "coal-rock" contact. It is possible then, to distinguish two types of contact:

(1) Exposed linear contact—corresponding to the case when driving across several pitching seams or coming up on a clay vein, and
(2) concealed plane contact—corresponding to mining parallel to the "coal-rock" contact.

In the first instance (figure 1-a) the pickup must determine the distance from the "coal-rock" contact; in the second case (figure 1-b)—the thickness of the coal roof or bottom. The mismatch signal appearing at the pickup output must be proportional to the distance from the contact, i.e. $\pm \triangle l_0$ or $\pm \triangle h_0$.

Experiments have been conducted to select optimum pickup parameters. In the course of these experiments the basic regularities of radiation intensity variations were determined as a function of various parameters, and a test pickup model was designed for initial experimentation under mine conditions.

The experimental model consisted of three units—a portable unit, a main unit, and measuring device.

The portable unit contained a radioactive source and the sensitive element of the pickup, i.e. radiation measuring tubes together with a pre-amplifier stage. The radioactive source (cesium 137 and selenium 75) was enclosed in a lead housing having a cone-shaped opening facing the scattering medium. Gamma-rays were thus permitted to leave through the conical opening and penetrate the strata next to the opening. Three-type STS-8 counters were located at the opposite end of the portable unit and were also enclosed in a lead housing. A slot in the counter housing permitted scattered (or reflected) gamma-radiation to enter and be measured by the counters. To provide the required mechanical strength, and in order to eliminate the influence of the medium's chemical composition (through absorption of soft gamma-rays), the opening in the counter housing were covered by Duralumin plate. A one-electron-tube pre-amplifier stage was mounted next to the counters. The entire portable unit was protected by a 3-mm steel cowl and was connected to the main unit with a flexible cable. The over-all

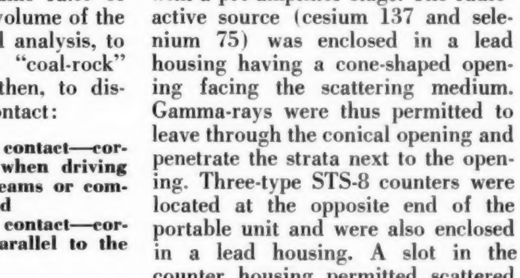

Fig. 1. In the first instance (left), the pickup must determine the distance l_0 from the "coal-rock" contact; in the second case (right), the thickness h_0 of the coal. Note that "1" in the figure refers to coal and "2" to rock

* *Translated from UGOL' (Coal) October 1960, published by Gosgortekzdat (the Government Technical House for Mining Literature) Moscow.*

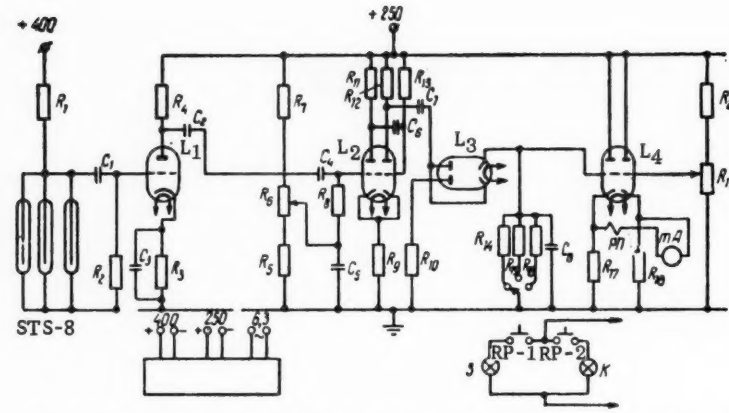

Fig. 2. The pickup circuit consisted of radiation indicators, STS-8 counter-tubes, a pulse-shaped normalizing stage, an integrating circuit, and a bridge circuit to identify mismatch signals

dimensions of the unit were 90 by 90 by 600 mm.

The main unit, including the electronic transducer circuit and the power supply block, was encased in a metal container provided with signal lamps on its lid.

The measuring device was a milliammeter. It permitted any deflection from the contact to be observed visually.

The pickup design may be altered and adapted to any type of machine.

The pickup circuit consisted of: radiation indicators; STS-8 counter-tubes; a pulse-shape normalizing stage; an integrating circuit, and a bridge circuit to identify mismatch signals.

The circuit is shown in figure 2.

The reflected (or scattered) gamma-rays, on reaching the counter tubes, generate electric pulses in the load circuit. The average frequency of these pulses is proportional to the intensity of the registered reflected radiation. Since these pulses are not constant in shape, they are delivered into the normalizing circuit consisting of a trigger with one stable state with a cathode coupling, both a part of tube L_2. At the output of the circuit, pulses are formed which coincide in time with the input pulses while having a constant shape (π-shaped pulses of constant length).

Subsequently these pulses are delivered through an isolating capacitor and limiter diode L_3 into the integrating unit consisting of resistor R and capacitance C. A constant voltage is created in the integrating unit. Its magnitude is proportional to the mean frequency of pulse delivery, i.e. to the intensity of the reflected radiation measured by the tube counters.

Voltage is supplied to the left-hand triode grid circuit of tube L_4 which is a twin triode. Both triodes are connected in a bridge circuit.

This electronic bridge is balanced when the value of the left-hand triode displacement voltage U'_c is equal to the displacement voltage U''_c delivered to the grid circuit of the right-hand triode. The U''_c voltage is removed from the voltage divider and may be regulated.

The selection of $U''_c = U'_c$ is made so as to assure that the position of the sensitive element corresponds to the present position, i.e. when deflection $\triangle l_0 = 0$. In this case the displacement of the sensitive element from the "coal-rock" contact leads to the unbalancing of the bridge, and, consequently to the appearance of a mismatch signal proportional to the distance from the contact.

Any further utilization of the mismatch signal depends on the type of mechanism selected and the method of control. In particular, for the case of relay control of the cutting bar, a polarized three-position relay may be connected into the bridge diagonal (figure 2).

The following characteristics of the pickup were obtained in laboratory tests with a model coal seam:

(1) The range[1] of measurements for a linear "coal-rock" contact, within the limits for a given design of instrument, has the value of ±10 cm when cesium 137 is used as a source of radiation, and ±6–8 cm with selenium 75;

(2) the response of the pickup within these limits comprises 1v/cm for cesium 137 and 2.5 v/cm for selenium 75.

(3) The maximum thickness of coal that can accurately be measured is not greater than 10 cm; moreover, when the thickness is greater than 8 cm the relationship becomes essentially nonlinear.

(4) The sensitivity of the pickup amounts to 4 v/cm for cesium 137 and 6 v/cm for selenium 75 whenever the distance to a plane contact is varied.

(5) A ±10-percent variation of the supply voltage causes no appreciable error in the instrument readings.

The accuracy of the pickup readings is substantially affected by the clearance between the instrument and the coal or rock moss. To assure normal operation this distance must not exceed a few millimeters.

Field Tests

Experimental testing of the pickup was carried out in the mines of Mining Administration No. 3–80 of the Frunze Coal Trust of the Lugansk Sovnarkhoz (Regional Economic Administration), where operations are in progress in four coal seams (h_6, h_8, h_{10}, h_{11}), each having a density of about 1.6 g/cm^3. The enclosing rocks are mainly represented by argillaceous and sandy shales ranging in density from 2.05 to 2.66 g/cm^3. In isolated cases the enclosing rocks are separated from the seam by a thin interlayer of carbonaceous shale, the density of which approaches that of coal.

Tests on linear contact were conducted in the following way:

The pickup was set on its stand so as to align the center of the instrument with the "coal-rock" contact. At the same time the bridge circuit was brought to balance at a zero-point with potentiometer R. Thereafter, the block was shifted in the direction of the coal or the rock. After each, 1 to 2-cm displacement, a reading was taken, i.e. readings were taken of the voltmeter connected in parallel with the integrating unit, and of the milliammeter connected into the diagonal of the bridge circuit. Since the entries in this mine were driven by conventional mining methods and the serrations on the ribs, which were as great as 0.5 m, had to be removed by hand, measurements along the linear contact were taken on a limited scale.

The results obtained in these tests make it possible to pass judgment on the response and accuracy of the pickup operating in varying conditions, on the spread resulting from the inconsistency of the enclosing rock density, and of the errors from the electric circuitory of the pickup. The accuracy was ± 2 cm within a

[1] The measurement range is determined by the geometry of the sensitive element and may be extended if necessary.

range of up to 10 cm from the contact. The curve of the voltage at the integrating circuit as a function of the distance from the linear "coal-rock" contact is represented in figure 3.

Experiments on plane contact were conducted in the following manner: A barrier 0 to 20 cm thick was purposely left in the breast. The portable unit was set on the barrier and moved from rock to coal. The bridge circuit was balanced for barrier heights of from 3 to 5 cm. The results characterizing the accuracy of the pickup performance are shown in figure 4 for cesium 137.

As it may be seen from the diagram, the variation of density of the enclosing rocks within the given range involves an error in measurement of the distance to the "coal-rock" contact within the limits of ± 0.5 to ± 0.75 cm for a 6–7 cm thick barrier.

The accuracy of measurement drops with increasing barrier thickness.

The performance of the pickup was also check for measurements of the distance to a "carbonaceous shale-rock contact." Tests have shown that, insofar as the density drop remained considerable, the pickup response remained almost unchanged. In measurements of the distance to the "coal-carbonaceous shale contact," a sharp decline in sensitivity was registered in view of the closely approaching densities.

According to the experimental data the follow-up relay operates reliably when the pickup's portable unit is moved ± 3 cm away from the linear contact and ± 1 cm away from the preset distance in relation to the plane contact.

An attempt was also made to utilize the pickup as an indicating instrument on the universal mining machine "Gornyak." The portable unit of the pickup was mounted on the loader, and the main unit, together with the recording instrument, were fixed in the front part of the machine near the operator. The pickup operated satisfactorily at the machine speeds used in the tests—0.27 and 0.54 m/min. In all cases the performance of the follow-up relay was satisfactory with the barrier thickness varying ± 1 cm, its nominal thickness being 3–5 cm.

It is important to consider the protection of personnel from the radioactive source. Existing regulations require that persons, who by the character of their work are not connected with radioactive preparations, should not be exposed to an irradiation dose exceeding 0.005 roentgens per daily shift. Utilization of soft gamma-radiations, such as cesium 137, facilitates the observance of this rule. Calculations show that adequate protection from the amount of cesium 137 used in the instrument is assured by a lead housing 4–5 cm thick. Since the pickup is located at the cutting bar—in the immediate proximity of which the presence of men is excluded during the operation of the machine—the use of the pickup involves no danger whatsoever for servicing personnel.

The only requirement which must be observed consists of keeping the channel (through which the flux of gamma-radiation enters the scattering medium) well covered with a special protective plug during the periods when the machine is not working. A simple mechanism will permit this operation to be carried out automatically. The long half-life of cesium 137 (33 years) eliminates any kind of special treatment of the radioactive source during the life of the machine.

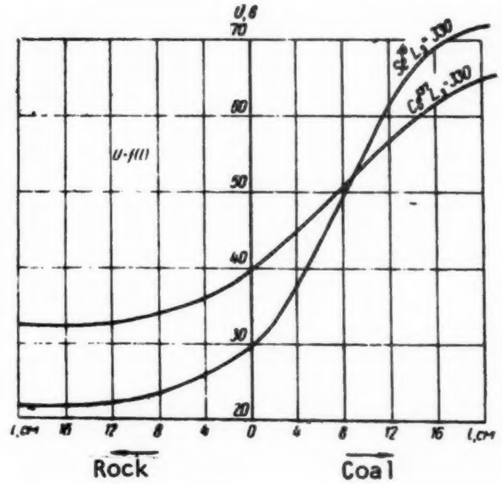

Fig. 3. Voltage at the integrating circuit of the pickup as a function of displacement in relation to the exposed linear contact (as registered in mine tests)

A conclusion may be drawn from the above discussion that the principle of utilization of scattered gamma-radiation effect may be applied for the development of pickups for checking and controlling the predetermined motions and regulating the "bite" of mining machines in accordance with the hypsometry and the thickness of the seam, and that work should be continued in this direction.

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2. Segalin, V. G., Rudanovsky, A. A. "Atomic Energy," Vol. 4, January 1958.
3. Boch-Bruyevich, A. M. "Application of Electronic Tubes in Experimental Physics," Gostekhizdat, 1956.
4. Gusev, N. G. "Handbook on Radioactive Radiations and Protection." Medziz, 1956.

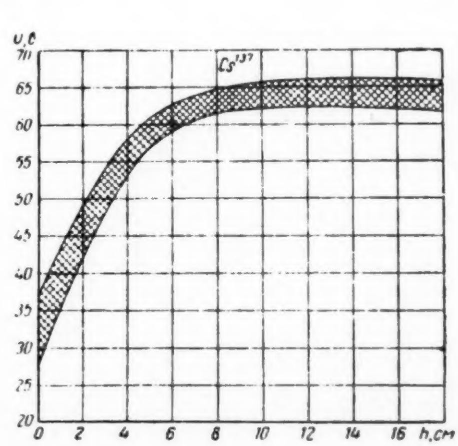
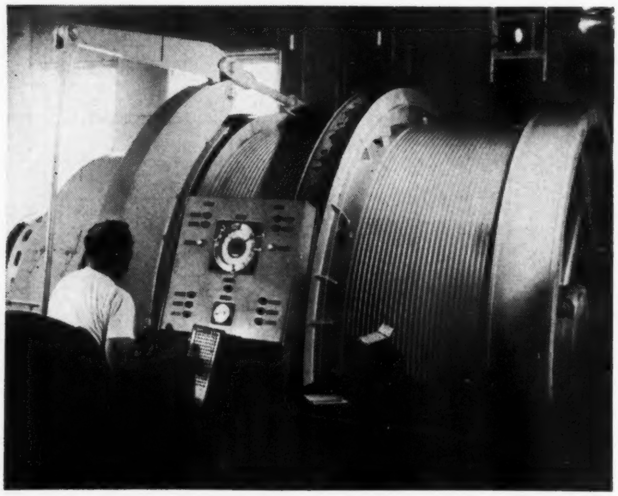


Fig. 4. Spread of data obtained in the measurement of a coal split



Conversion of a Drum Hoist To Koepe Friction Type

by JAMES R. GRONSETH,

Mechanical Engineer
Inland Steel Co.

Greater depth and more capacity were required of Inland Steel Company's Bristol mine hoisting system. By adapting the Koepe friction system to the existing equipment the problem was economically solved

EVER since the first Koepe friction type hoisting system was introduced to this continent in 1953, there has been increasing interest in its use and application. Most of the interest has centered around new installations, but now, at the Bristol mine the Koepe friction principle has been applied to the existing drum type hoisting equipment.

At the Bristol mine, a vertical shaft hematite iron mine located in Crystal Falls, Mich., the main shaft hoists had reached their limits at the 1650 ft level, and it was necessary to sink 250 ft more to the 1900 ft level. The problem was to find the most suitable method of reaching this next level and possibly to go even deeper. It was also considered desirable to increase the hoisting capacity.

Various Schemes Considered

Naturally, cost was a serious consideration and this quickly ruled out the idea of completely new hoists. We considered drum dividers for the existing single drum hoists, but rejected the idea because it would have required three layers of rope. Because of the crushing effect on the bottom layer, we limit the number of layers to two. This scheme would not have increased the hoisting capacity either. We thought about an auxiliary shaft underground, but this would require rehandling iron ore, men, and supplies. An incline conveyor was considered quite feasible. This would keep the hoisting capacity at least equal to the existing capacity, but it would have also required rehandling men and supplies. In addition any further deepening of the mine would present subsequent problems.

The successful idea, both economically and practically, was the conversion of the present hoisting system to a Koepe type friction hoisting arrangement. It was determined that with this system we could increase speed, payload and, consequently, hoisting capacity.

The principle of friction hoisting is certainly not new. Koepe installed the first Koepe friction mine hoist in Germany in 1877 and now there are many such installations in Europe. Building elevator manufacturers in this country have used the friction principle for years.

One friction type drive, known as the Bollen drive pulley, has been used for some time in this country and there is at least one still in operation. With this system the sides of the drive pulley squeeze the rope thus creating the necessary friction for driving power. There are other friction systems, but the Koepe principle is probably the simplest.

At the Bristol mine our conventional ground installation has remained virtually unchanged. However, instead of two ropes winding and unwinding from the drum, we now have a single rope leading from one skip, passing 180° around the hoisting drum and returning to the other skip.

Conversion of Hoist Cost $100,000

The types of friction material used for lining the drive pulleys are constantly being improved with the latest being a plastic material. Even the quality of this plastic has been improving in recent years. Other common lining materials are wood, leather and rubber.

Hoisting ropes have also been improving with about all known types being used on Koepe wheels. Several types are shown in figure 1. Locked coil ropes, not normally considered for hoisting in this country, have been used on multi-layer drum hoists in Europe.

The basic cost of the entire Koepe

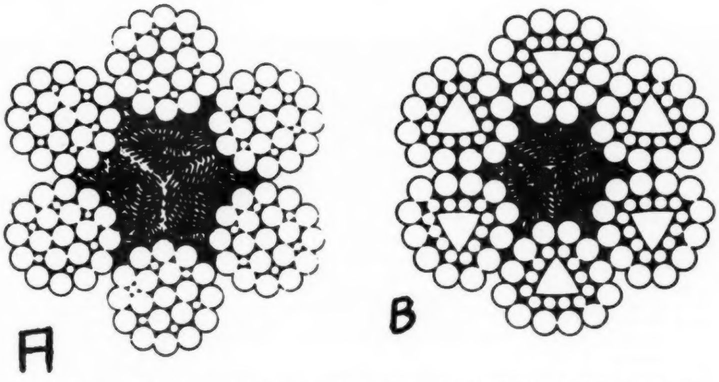
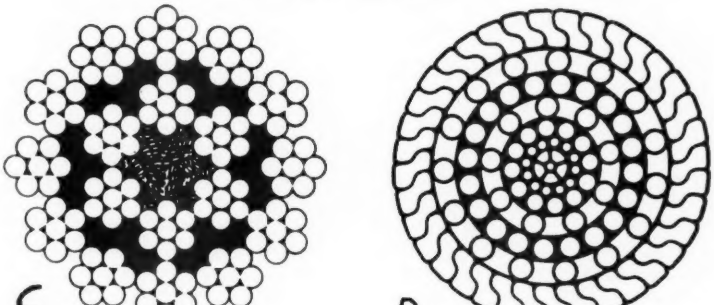


Fig. 1. Types of hoisting rope include (a) round strand, (b) flattened strand, (c) nonrotating, and (d) locked coil



conversion, including labor and material, ran to slightly less than \$100,000. This figure, however, excludes such items as loss of production, taxes, insurance, etc. The largest items in the cost included the hoist and tail ropes at \$32,500, four new headsheaves with roller bearings at \$17,000 and three new bottom dump skips at a total of \$15,000. Other cost items included the plastic tread material, turning and reinforcing of the hoist drums, electrical controls for spotting, synchronizers, reinforcing the headframes, and a new cage.

The mine was out of operation for slightly less than three weeks while the installation was completed. This, however, was during the winter and perhaps could have been reduced under better weather conditions.

Existing Equipment was of 1917 Manufacture

The hoisting system consists of two single drum 400 hp hoists manufactured in 1917. Both of these hoists are manually operated with a-c drives. The skip hoist had a second 400-hp motor added in 1927 because of increased loads. The cage hoist operates a double-deck cage in balance with a counterweight. The skip hoist operated two 100-cu ft capacity Kimberley type skips in balance. Prior to conversion, 1¼ in. diam round strand ropes were used on both hoists.

Theoretical Hoisting Capacity Increased 35 Percent

Because the skips were in balance, a feature we wished to retain, the conversion of the skip hoist to a Koepe drive was a bit more of a problem than the other American Koepe hoists because we are always one full load out of balance. Most new designs have a skip in balance with a counterweight so that the maximum out-of-balance load is only one-half the full load.

It was necessary to study several sizes of rope in order to arrive at the proper Koepe hoisting relationships such as tension ratios, tread pressures and, of course, the usual factor of safety. Of the several combinations of rope sizes that were studied, it was determined that a 1⅝-in. diam flattened strand pull rope would be the most satisfactory. By using this larger rope we were able to increase the payload from 4.5 tons to 5.5 tons and increase the effective drum diameter with the Koepe adapter ring which increased the hoisting speed from 1040 fpm to 1200 fpm. These improvements increased the theoretical hoisting capacity 35 percent.

In order to obtain better weight ratios, while the skips are dumping, the overturning type skips were replaced with modern bottom-dump skips. Other advantages were gained with the bottom dump skips, such as faster and complete dumping of sticky ore, improved skip loading with less spillage, and less racking in the headframe.

One question that came up when working on a Koepe multi-rope installation at Inland's Caland Ore Co. was: What effect will dirty ropes have on the plastic friction material? To find out the answer to this question, samples of hematite ore were sent to the ASEA Co. in Sweden where tests were made on their PVC (polyvinyl chloride) friction material using both wet and dry ore on a rope. The test actually showed that the dirtier the rope the better the friction, probably due to the fact that hematite is a very abrasive material.

The pull ropes are galvanized to prevent corrosion since the usual grease would obviously reduce the friction necessary for the driving force. Tail ropes are also galvanized and then covered with a heavy tar-like grease. The reason for using both galvanizing and grease is based on the experience of other Koepe installations in this country.

Tail Ropes Hung Off Center in Out-of-Plumb Shaft

Since the Bristol mine shaft is out-of-plumb, due to mining subsidence, there was some concern as to what effect this would have on the tail ropes in the small 18 in. wide counterweight compartment. To compensate for the misalignment, the tail ropes were purposely hung 2½ in. off center in the compartment.

Another Koepe consideration is the proper fleet angle between the rope and the friction groove. The permitted maximum for friction hoists is 1° 30′. The Bristol mine's fleet angle of 0° 25′ is well within this limit and should not cause any problem.

With the new skips, the heavier pull rope, and tail ropes, the total suspended load on the skip hoist was increased from 36,000 lb to 60,000 lb. With this friction type system the pull rope always remains in the center of the drum, and therefore, in spite of the great load increase, the maximum load on each hoist bearing was increased only 3000 lb (from 27,000 lb to 30,000 lb). Because of these increased loads, the strength of all parts of the hoists and headframe were

studied. Except for the cast iron drum on the cage hoist, the hoists were adequate. Since the reinforcing cost was nominal, the drums on both hoists were reinforced. Study of the headframe showed that the headsheave girders needed reinforcing for the additional loads.

Drum Jacks Installed to Reinforce Drums

In order to reduce down time as much as possible, much of the preliminary work was done prior to the shutdown.

To hold the PVC tread material in the center of the existing drums, a two piece Koepe adapter ring was fabricated (figure 2). To insure a close fit, the middle two ft of the hoist drums were turned down to suit the adapter ring diameter after fabrication. Turning was done with a planer head mounted in front of the hoist drum, and the regular hoist power was used to turn the drum while cutting. The rings were then bolted to the drums. The standard method of holding the plastic material in a U groove with wedge shaped wood blocks was used (figure 2).

For drum reinforcement, five sets of drum jacks were added to each hoist. To accomplish this, large steel clamps were added to the drum shaft just inside the hubs. These clamps are tied together along the shaft with tie bars which keep the clamps from spreading. One end of a drum jack is fastened to a clamp and the other end is fastened to the center of the hoist drum. The purpose of the jacks is to help carry the load to the shaft bearings and relieve some of the drum stresses (figure 3).

To correct for rope creep, it was necessary to install a synchronizing device. To do this, a small section of the Lilly drive shaft was removed and the device was installed in its place. The synchronizing device permits the hoistman to adjust his indicating devices so that they correspond with the conveyance location in the shaft. We used the same type of device that is used on new installations.

The indicator for the hoistman is the two pointer type, similar to the face of a clock. One pointer rotates slowly, traveling about three quarters of a revolution per trip, to give approximate location, while the other pointer travels quite fast, making many revolutions per trip, so as to permit accurate spotting. Final spotting is done by magnetic switches in the shaft that activate indicator lights in front of the hoistman.

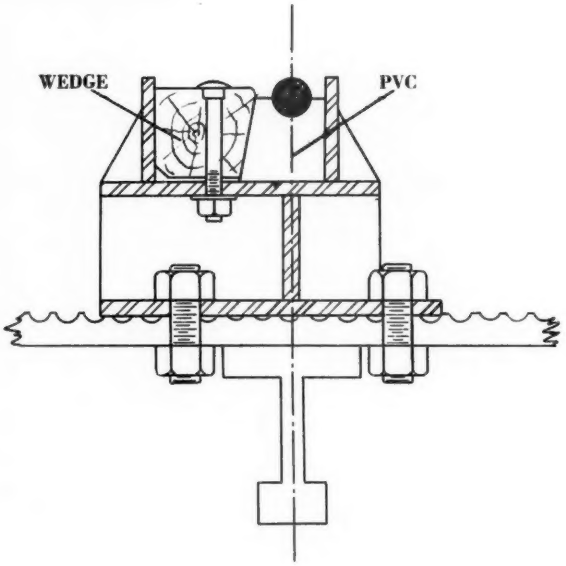


Fig. 2. Section through Koepe adapter ring shows method of wedging used to hold PVC tread material in U groove

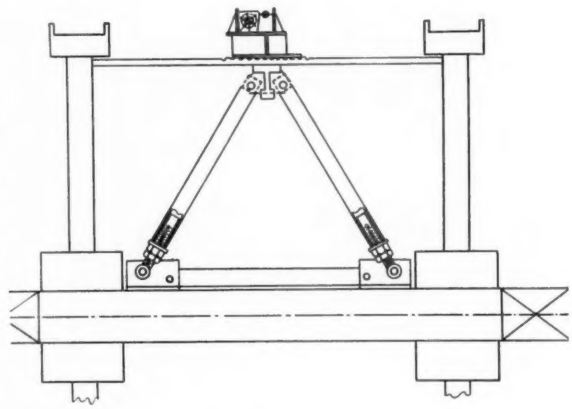


Fig. 3. Section through hoist drum shows positioning of drum jacks which were installed to help carry the load to the shaft bearings and relieve some of the drum stresses

Because of the size of the reels, the pull ropes had to be installed from surface. To do this, a small foundation was constructed with a simple post brake to fit the pull rope reel. The rope was lowered most of the distance of the shaft with the reel brake and a safety clamp at the shaft. Final lowering was done with the safety clamp and a tractor.

It was previously determined that one tail rope would be too large to make the free loop from one compartment to the other at the bottom of the shaft. Consequently, two smaller ropes were used for the tail ropes. These were installed from underground and fastened at both ends by free swivels.

Correcting Start-Up "Bugs"

When mining operations were started again at the Bristol, the usual difficulties developed. It was quickly noticed that there was too much voltage drop in the safety control system between the limit switches in the headframe and the engine house. This was remedied by adding relays to the system.

Even though the tail ropes were purposely hung off center in the small counterweight compartment to compensate for shaft misalignment, they swayed slowly from side to side and rubbed on the steel sets. Because of this, it was necessary to line the counterweight compartment in several places with wood. This seems to be solving the problem quite well with very little wear to either the wood or the tail ropes. Since the tail ropes have only their own weight to support, they can be guided with very little effort even when moving at full speed.

Spotting of the cage and the two skips is done with magnetic switches located in the wood guide runners at the proper position at each of the levels. Magnets are suspended under

Bristol Mine Cage Hoist Data (Koepe Friction Type)

Cage Load lb	T1/T2[1]	Tread Pressure psi	Rope Factor of Safety	Max. Accel. on plastic $u^2 = .2$
0	1.25	162	11.7	All allowable accelerations in excess of 4 fps²
4,000	1.0	178	11.7	
6,000	1.1	189	10.7	
8,000	1.20	198	9.8	
10,000	1.30	206	9.0	
12,000	1.40	216	8.4	
Rope in balance with cage	1.51			
Rope in balance with ctw.	1.06			

[1] *T1/T2 is the pull rope tension ratio*
[2] *u is the coefficient of friction*

Counterweight weight, lb	*10,380*
Rope (1⅝ in. diam, 4.75 lb/ft) weight, lb	*9,800*
Breaking strength, lb	*236,000*
Cage weight, lb	*6,500*
Depth, ft	*2,060*
Drum diam, in.	*138*
Man load, lb (30 @ 200 lb ea.)	*6,000*
Design acceleration, fps²	*2*

Bristol Mine Skip Hoist Data (Koepe Friction Type)

Ore Load Long Tons	T1/T2[1]	Tread Pressure psi	Rope Factor of Safety	Max. acceleration on plastic in fps² with: $u^2 = .2$	$u^2 = .3$	
4.5	1.43	255	7.0	4.0	8.5	
5.0	1.48	260	6.8	3.5	8.1	
5.5	1.52	265	6.6	3.1	7.7	*Max.* Bristol Design
6.0	1.57	270	6.4	2.6	7.3	
6.5	1.61	275	6.2	2.2	6.8	
7.0	1.66	280	5.9	1.7	6.4	
Rope in balance with 13,800 lb skip	1.4					
Rope in balance with 11,800 lb skip	1.2					

[1] *T1/T2 is the pull rope tension ratio*
[2] *u is the coefficient of friction*

Skip weight, lb.	*13,800**
Rope (1⅝ in. diam, 4.75 lb/ft) weight, lb	*9,800*
Breaking strength, lb	*236,000*
Depth, ft	*2,060*
Drum diam, in.	*138*
Design acceleration, fps²	*2*

* Includes 2000 lb of extra weight added to each skip to maintain the proper T1/T2 ratio. These weights will be replaced by the weight of the extra rope required to reach deeper levels while maintaining the same tread pressure.

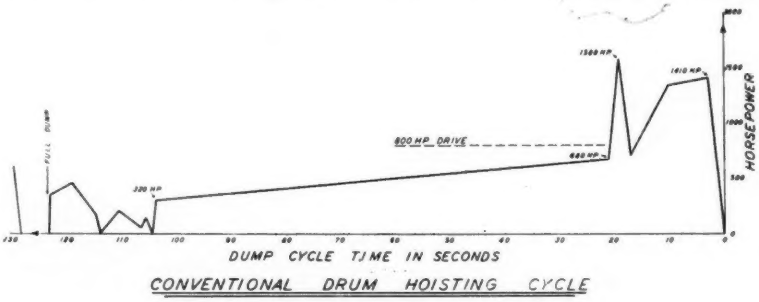
the conveyances. With this system of spotting the problem of spillage was solved by interlocking the underground pocket gates with these spotting switches.

Also interlocked were the hoist control and the underground pocket gates so that the hoist could not be operated with the gate open. However, if the hoist brake is out of adjustment when the skip is being loaded, the load is able to force the skip down the shaft and because of the interlocking, the hoistman is unable to apply power to the hoist. We are now installing an emergency brake on the motor coupling to handle such situations.

An unusual situation is the buildup of static electricity on the ropes in the hoist area. A system of wipers could be installed, but nothing is planned since no problem exists.

The synchronizers which were installed between the depth indicators and hoists are adjusted manually to compensate for rope creep. When the ropes were new, adjustments were made quite often because of the initial rope stretch. Now the frequency of adjustment depends upon the uniformity of the load weight. If the adjustment becomes too much of a burden to the hoistman, it can be done automatically by using a few controls similar to those used on new installations.

At the Bristol mine, there is very little overtravel room in the headframe. Since the skip speed has been increased, we found it necessary to readjust the Lilly control retard cams in order to prevent the skips from hitting the headsheaves during an emergency stop.



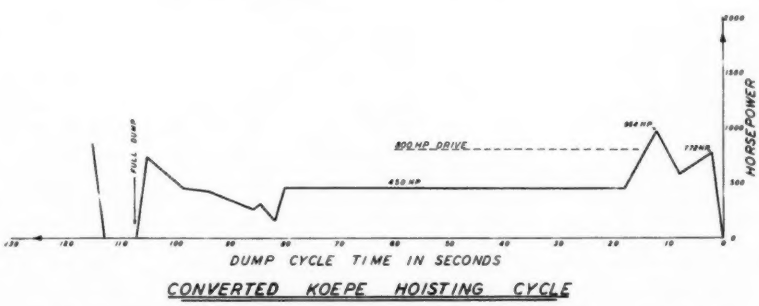


Fig. 4. Hoisting cycles of conventional drum hoist and drum hoist converted to Koepé system. Note reduced starting power requirements with Koepe type hoist

Starting Power Requirements are Down 45 Percent

In an attempt to compare power used during the hoisting cycle before and after the conversion, a recording wattmeter was installed on the skip hoist, but it was found virtually impossible to make a true efficiency comparison with a manual hoist. The amount of breaking varies not only from man to man, but also from cycle to cycle.

One thing that was obvious, however, was the reduction in starting power requirements. The Koepe friction type method required only 772 hp to start, whereas 1410 hp were required to start under the drum hoisting method, (figure 4). Tail ropes

(Continued on page 69)

Experience With A-C Mining

Union Carbide has spent 20 years in developing an efficient a-c mining system. Excellent production records, economy and safety of operations have been the end result

By OTIS G. STEWART
Executive Engineer-Coal Mining
Union Carbide Metals Co.

THIRTY-SEVEN years ago, as a young engineering graduate, the writer began his first formal employment in a coal mine in central Illinois. Many early experiences made lasting impressions on his youthful mind, not the least of these being his first brush with the use of a-c as a power medium for face operation. Even though this was a complete hand-loading operation, it had a dual electric system using three-phase, 440-volt a-c for coal cutting and 250-volt d-c for main line haulage with storage battery gathering haulage.

In subsequent years his experience was with all d-c operations. By comparison these operations did not measure up in over-all performance with that to which he had been accustomed in those earlier years.

In early 1931, after stopovers in Indiana and Kentucky, the writer returned to his native State of West Virginia and secured employment with Union Carbide Metals Co. at a coal mine which it had recently purchased. This was a conventional hand-loading operation of the 250-volt d-c variety.

In the late 1930's, changing economic conditions pointed out the need for increased production of coal from this mine, which served a steam electric power station located on the bank of the Kanawha River. This steam electric station, in conjunction with a nearby hydroelectric station, supplied a ferroalloy plant with primary electric power for the operation of several large submerged arc electric furnaces.

In passing, it is interesting to observe that, since such a large source of captive electric power was available nearby, it was only logical that the company should want to profit from the economy of substituting this for purchased power at that time in use at the mine. To accomplish this a rather unique local condition was created which was dictated by the fact that electric power generated at both the steam and hydro stations was 25 cycle while the coal mine, which had been acquired by purchase in advance of actual plant construction, was fully equipped to operate on 60-cycle power. By use of a frequency converter, purchased electric power was changed from 60-cycle to 25-cycle during plant construction and the initial start-up of the power station. In turn this process was reversed and 25-cycle power was changed to 60-cycle later for operations at the coal mine.

Factors Affecting the Selection of A-C as a Power Medium

The area of available coal adjacent to the plant site lay between two previously abandoned mines. The coal area at its nearest point was located about $1\frac{3}{4}$ miles from the power station and extended in a narrow corridor to the north which spread out to the east for an additional distance of $2\frac{1}{2}$ miles. This indicated that eventual transmission distance of electric power would approximate $4\frac{1}{4}$ miles. Rule of thumb calculations confirmed that 4160 primary distribution voltage would be adequate to work out the entire property.

The physical shape of the coal reserve was such that the bulk of the tonnage would be moved against maximum grade during transportation to the surface. This indicated probable large peak demands with consequent frequent power interruptions. The configuration of the surface overlying the coal seam was extremely steep and rugged. Proper servicing of face operation with adequate power with satisfactory secondary face voltage meant locating conversion units on the surface at the top of boreholes, or at underground locations near face areas.

A preliminary analytical study of the use of a-c as compared to d-c as a power source for face operation indicated that the former possessed certain important advantages:

1. A sizeable saving in first cost of conversion equipment.
2. Greater ease in locating conversion equipment adjacent to face area and greater flexibility in the movement at reasonable cost of the same to new locations.
3. Possible use of higher transmission voltage resulting in a considerable saving in conductor costs and potential improvements in voltage regulation.
4. Reduction of shock and fire hazards due to more efficient switching equipment and better protective relaying systems.
5. Reduced maintenance costs resulting from:

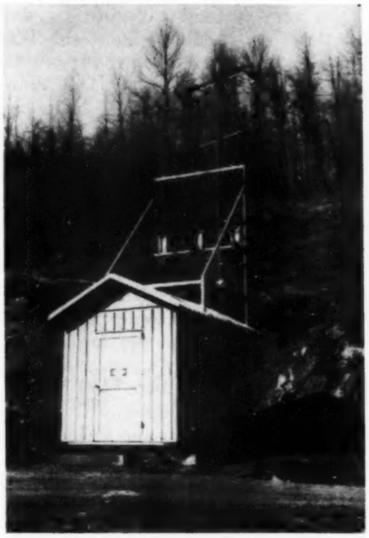
(a) Elimination of conversion equipment of the rotating type.
(b) Use of a more rugged and an inherently safer type of electric motors in all face operating areas.
(c) Elimination of the always troublesome resistance units necessary to the operation of d-c motors.
(d) Use of simplified single-step motor starters with quicker and more efficient arc quenching characteristics.
(e) Fewer burn-outs of motors due to the ability of most a-c motors to withstand a limited amount of stalling until the load is reduced or protective equipment removes it from the source of power.

6. Increased efficiency of transformers as compared to the conversion units necessary in d-c systems.
7. Assurance of face operations at or near 90 percent efficiency due to better voltage regulation, simple and more rugged motors, and better overload protection.

The following set of assumptions and conditions heavily influenced the decision affecting the selection of equipment.

Even though it would be necessary to maintain the existing d-c system for underground haulage, it was concluded that the use of a-c for face operations would be economical and desirable. The life of the then existing mine was estimated at 15 years. Fu-

ture plans contemplated the mining of a limited amount of coal from a seam of questionable quality lying higher in the hills and blending this poor quality coal with existing production so as to supply a satisfactory end product. Eventual production would come from a new location somewhat removed from the original area. End planning contemplated the use of belt conveyors for main line transportation of all coal to the mine portal.



High voltage switching station includes cutouts and lightning arresters

Some of the Hurdles Encountered

Having decided upon a-c as a future power medium, it was decided to make the original installation just one step removed from the existing system—viz., hand-loading onto face conveyors, using room and mother conveyors, and employing elevating conveyors for final loading into mine cars. This proved to be a good training ground.

Within a comparatively short period low-vein mechanical loaders replaced the face conveyors. The shortwall cutting machines were mounted on low-type caterpillar trucks. When the upper seam was opened, belt haulage to the portal was effected, thereby eliminating all underground track haulage. In the final evolution all track haulage has been eliminated and the mine can now be classed as a complete a-c operation. At this point the desirability of making such a change in easy steps should be pointed out. The effect of any major operational change on average mining personnel is frequently severe. In many instances such changes serve to trigger labor disturbances sometimes resultin work stoppage. When possible, drastic changes should be avoided. When not possible, such changes should be cushioned by assured offsetting advantages. Union Carbide's program was accomplished by comparatively slow evolutionary steps, the success of each being assured before additional progress was made. The company subscribes to the theory that all progress is change but not all change is progress.

It was indeed fortunate that the company decided to initiate such an evolutionary process. Once it started acquiring a-c equipment, troubles really mounted. Few if any permissible a-c machines were available and among the company's early procurement experience difficulties were the following:

1. The only permissible a-c starters available at that time were of the hand-operated type using fuses as the only protective devices.

2. The shortwall coal cutters purchased were the very first of their kind manufactured and were equipped with manual starters. These machines were part of a small group built for development test only and had not been released for sale.

3. There were no enclosed inert gas filled power centers available and it was necessary to have nonflammable liquid filled transformer stations custom built in a local repair shop.

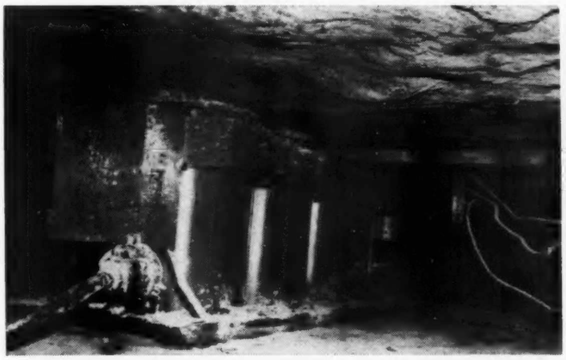
4. There were no satisfactory circuit centers for branch circuit protection available at that time so it was necessary to use custom built junction boxes and to protect circuits with a special adaptation of trolley nip type fuse.

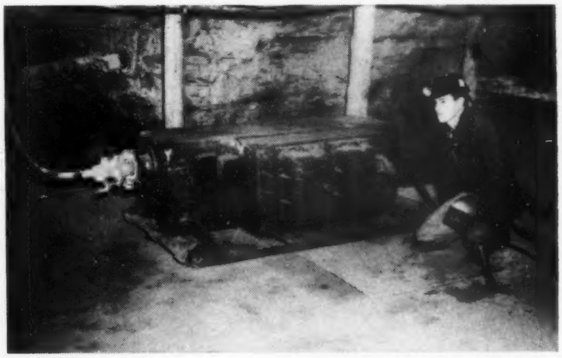
5. Early portable connectors were of the taper pin and socket type and required excessive maintenance. Excessive heating resulted from reduced contact area on the occasion of the accumulation of even a limited amount of foreign material in the connector socket or on the pin.

6. There were no a-c powered shuttle cars available at that time and repeated requests for quotation were met with a reply to the effect, "What's the matter with you, are you crazy?" One manufacturer's engineer magnanimously offered to design and build an a-c shuttle car if Union Carbide would bear the entire cost of development.

7. In an attempt to modernize as equipment became available, an order for a 220-volt a-c continuous miner was placed with a manufacturer in September 1948. In March 1951 the coal concern was advised that no design for an a-c machine was available and it was suggested that it accept delivery on a d-c machine. The order was cancelled. In April 1951 an order was placed with another manufacturer for a 220-volt a-c continuous miner of different design. Four weeks delivery was promised. When the manufacturer's home office learned that this was to be an a-c machine, promised delivery was extended to eight months. Final delivery was effected in late October 1952. This was an elapsed time of 18 months. The over-all elapsed time from placement of the original order to final delivery of an a-c continuous miner was four years and two months.

Procurement difficulties were by no means the only ones encountered. Soon after operations began the company was beset with many unreasonable restrictions and criticism from State and Federal mine inspectors. So long as the manual starters and visible fuse were used, the inspectors could follow their inspection ritual





Skid-mounted 112½-kva pyramol-filled 4160/2300-440/220 volt transformer bank (left) and 75-kva nitrogen-filled 4160/2300-440/220 volt power center (right). Both include polarized high voltage connectors and low voltage circuit breakers. One advantage in using a-c as a power source for face operation is the increased efficiency of transformers as compared to the conversion units necessary in d-c systems

and detect violations. When magnetic starters became available and protective relay systems were installed, the company was cited many times for violations, even though its procedure included safety precautions admittedly superior to those required by the code.

In one instance a violation citation was repeated for two years by a Federal inspector because the company would not open up and install lightning arrestors in a 5000-volt multiple conductor type SHD rubber-covered cable at its point of entrance into the mine. He cited Article VIII—section 1b of the Federal Mine Safety Code which reads as follows: "Surface transmission lines including trolley circuits shall be protected against short circuits and lightning. Each *exposed* power circuit that leads underground shall be equipped with lightning arresters of approved type at the point where the circuit enters the mine." The fact that there were three properly installed approved type lightning arresters 250 ft away at the terminals of the shielded power cable did not affect this inspector's opinionated decision. Eventually his transfer to another district effectively removed this violation citation.

From the recitation given above one might conclude that the remark previously attributed to a salesman when he was asked to quote on an a-c shuttle car accurately described the company's state of mind when it decided to adopt a-c as the exclusive power medium for its coal mine. Good judgment certainly prevailed when the company decided on a step-by-step evolution from d-c to a-c.

Experiences With A-C Mining

After some 20 years of trial and error and with the assistance of manufacturers' representatives, Union Carbide has succeeded in equipping what it considers a highly satisfactory and very efficient a-c mining system. Safety, portability and simplicity have been the controlling factors. Excellent production records, economy and safety of operations have been the end results.

Safety-wise the company can point with pride to its record. On February 5, 1960 the mine completed four years and four months of operation without a disabling injury. During this period one mine was closed down and a new one opened up.

The company is quite proud of its production record. During the calendar year 1959 the mine operated 246 days and produced 250,700 tons of coal. Total employment was 64 men including all supervision. Productivity for the year was 16.5 tons per man-shift for all employes and 27.8 tons per man-shift for each production man. Production performance has been steadily improving. For February 1960, these figures were 21.17 and 34.66 respectively.

If necessary protective equipment is satisfactorily maintained, it is highly improbable that an a-c motor or its cables will be burned up because of low voltage. Reduction in voltage reduces the output torque of the motor in direct proportion to the square of the voltage. Under conditions of extreme low voltage and required high torque the motor will stall out and remain so until the load is reduced or it is removed from the line by protective equipment.

This characteristic serves as an incentive to the company's supervisory personnel to maintain adequate face voltage. Because of the comparative ease with which transformers may be moved closer to the load center, it has never experienced such adverse conditions. This assists in the maintenance of a uniformly high level of operating time and a consequent satisfactory productivity.

Electric maintenance during the period of a-c operation has been gratifyingly low. During 20 years of operations the mine has experienced the following failures of electrical equipment:

(a) One single-phase, 4160/220 volt, 37½-kva, Asserol filled transformer
(b) One three-phase, 4160/220 volt, 75-kva, nitrogen filled transformer
(c) One 35-hp stator on a cutting machine
(d) Two B-250-J, 5-hp traction motor stators on loading machines
(e) Two 5-hp stators on face conveyor motors
(f) One 7½-hp stator on an auxiliary fan motor which was remotely controlled.

During this period the mine produced in excess of 5,000,000 tons of coal.

There has not been a single failure of for main or cross conveyors, belt conveyors, pumps, cutting machine crawler trucks or hydraulic drill power units.

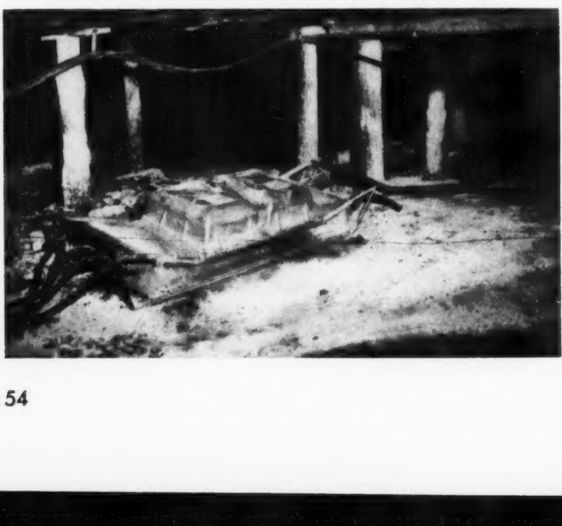
Management feels that a further dividend maintenance-wise has been realized from a-c operation in a lessened incidence of mechanical failure. Part of this may be attributed to the fact that so-called rawhiding of equip- is virtually impossible. No longer can machine operators, when operating at low voltage, compensate for slow speed by shunting out a field coil.

Experience with electric cables has been remarkably good. There has been no replacement of any of the original 5000-volt rubber-covered type SHD cable. There has been a one percent annual replacement of secondary single conductor cables. There has been a ten percent annual replacement of multiple conductor secondary cables. There has been no replacement of portable connectors on the 5000-volt electric cables. There has been a five percent annual replacement of portable connectors on the secondary 600-volt cables.

There has been no shock or burns from electric equipment or cable failure or from misapplication. The com-

(*Cont. on page 59*)

Face units for control and safety include low voltage distribution box (left) and face safety circuit control center (right)



Modern Theory of the Electrical High Tension Process

By R. E. BARTHELEMY
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Jacksonville, Fla.

THE electrical high tension beneficiation process can be said to have come of age among the classical methods of mineral dressing three years ago, when it was successfully applied to the beneficiation of certain difficult iron ores, as reported by the writer at the American Mining Congress meeting in San Francisco in 1958.

The original work on electrostatic separation must be credited to H. B. Johnson, the father of this technique. All of the machines that are presently on the market (Sutton, Lurgi, Carpco, etc.) are very similar to the original Johnson machine, the differences being essentially in the arrangement of the mechanical elements. All interesting patentable facts are well covered by the Hewitt patents which expired in March 1960.

Early Charging Methods Limited Applications

As long as electrostatic separation was limited to the original methods of charging particles by induction or conduction, the charge q which could be applied to a particle was quantitatively very small, and the resultant electrical field $\vec{F} = q\vec{E}$ developed in an electrical field $\vec{E}$ on which to base a separation, was of limited value. That was the period of the plate separators and the early low speed rotor separators. With these machines, separation was based upon the small deflection imparted on the natural gravitational trajectory by the electrical attraction of a charged plate upon an oppositely charged particle in a stream of mineral particles having charges of different polarity.

Under these circumstances, and in view of the low capacity of the machines, electrostatic separation techniques did not find a ready field of application in mineral beneficiation when gravity methods and flotation could solve efficiently all the problems presented by economic minerals of the time.

In the early forties, when titanium minerals started to become valuable, electrostatic separation found its first important application in separating heavy minerals from Florida beach sand deposits. The technical staff of Humphreys Gold Corp., including J. H. Carpenter, deserves a large measure of credit for early developments of this technique.

It was, however, R. G. Mora's thesis at M. I. T. in 1958 which first clearly exposed the principles upon which modern high tension machines are based.[2] A complete modern theory of the rotor type industrial machine has since been developed showing the crucial importance of rotor diameter when the machine is used for the beneficiation of milled minerals.

Before discussing the mechanics of separation in one of the classical machines, it is necessary to clarify some theoretical points concerning the method of particle charging. Charging, by induction or conduction, is too well-known and elementary a phenomenon to warrant explanation. We will, however, discuss ion bombardment charging, and try to clearly explain how it works, since a good understanding of this method of charging is needed in order to grasp how modern high capacity machines operate.

Ion Bombardment Charging

The best known source of ions to effect such a charging is the corona field which develops naturally between an electrically charged cable and the ground. This field is sometimes noticeable on high tension electric lines as a hissing noise or as a glow that can be seen around the wire at night. These manifestations occur when the electrical potential is high enough and the charge density on the wire becomes so great that the surrounding medium cannot contain it. The phenomenon is due to the ionization of air surrounding the wire and the resultant constant flow of gaseous ions that is generated between the wire and the ground. This flow of ions can be extremely intense and is susceptible of charging all particles of matter which enter the corona field.

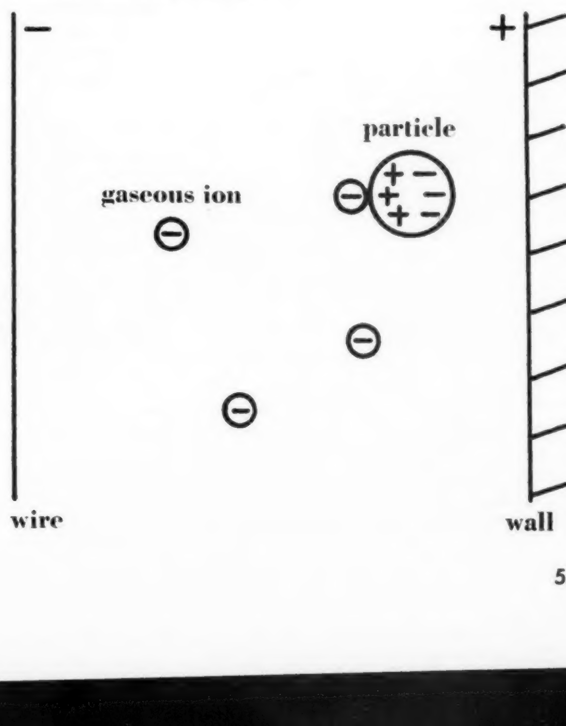

Fig. 1. Simplified diagram of the charging of a freely falling mineral particle in an ionic field

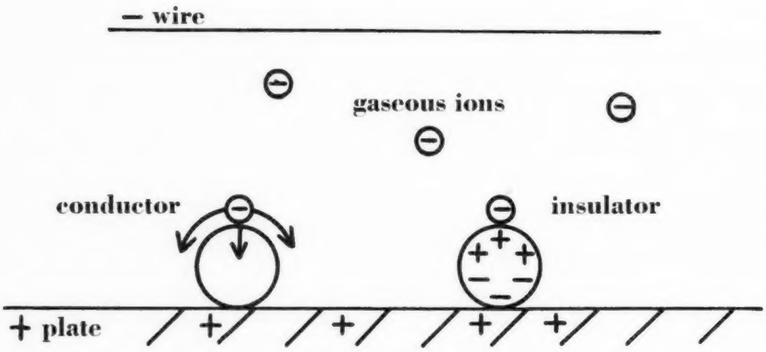

Fig. 2. Charging of grounded particles lying in an ionic field

The charging of the particles introduced into this field presents two distinct cases, depending on whether the particle is out of contact with the ground or in contact with it.

In the first case, a freely falling particle in a corona field between a vertical wire and a grounded wall becomes polarized, and gaseous anions tend to stick on any bound positive charge in the particle. After a certain time, the particle will consequently acquire a net negative charge whether it is a conductor or an insulator (figure 1).

A completely detailed mathematical study of this charging process was made by Pauthenier and Mora, who demonstrated that there is a definite limitation to the charge the particle can thus acquire, and this maximum charge Q_m is the following:

$$Q_m = 4\pi\epsilon_0 a^2 k E_i$$

in which: ε_0 = permittivity of free space (farad per meter)
a = radius of electrical equivalent ellipsoid (meter)
k = function of ellipticity c/a and dielectric constant (K_p) of the particle
E_i = ionic field strength (volt/meter)

For information purposes, the value of the factor k is given hereunder for three different shapes of particles —prolate, spherical and maximum oblate or flaky:

Shape	Charging shape factor k for:	
c/a	Conductor $K_p = \infty$	Non-conductor $K_p = 5$
5	36.20	27.15
1	3.01	2.15
0	0.666	0.532

The concept of this maximum charge which can be put on a particle can be easily understood if one assumes that after a certain number of ions have come to stick to the particle other ions can no longer be attracted and on the contrary are repelled.

Now from this mathematical expression of the maximum charge Q_m the following deductions, which will be of interest further on, can be made: All other contributing factors being equal, it appears that the maximum charge will be greater for a conductor than for a non-conductor, and that this charge will be approximately 12 times greater for an elongated particle ($c/a = 5$) than for a spherical one, while a flaky one could could acquire only 1/4 of the charge of a spherical one.

Let us now consider the second case, which is shown in figure 2, as a particle reposing on a grounded plate under a horizontal wire giving off a corona discharge. The particle is subjected to the same ion bombardment as in the preceding case, but if it is a conductor, there is a leakage of anions to the ground through the particle along its surface, while if the particle is a perfect insulator there is no leakage.

Consequently, if we had an absolutely perfect conductor, no charge could build up on it as it would leak out immediately; if we had a perfect insulator, the charge would reach the maximum charge previously indicated. However, in practice there is no such perfect insulator or perfect conductor, for there is always some leakage or some obstacle to it, as the case may be.

Relationship Between Steady State and Maximum Charge

Therefore, while the particle is under ion bombardment, there are at all times some ions moving simultaneously towards the surface of the particle (charging) and some others leaking from the particle to the plate (discharging). This process reaches an equilibrium that results in a steady state charge Q_s of the particle, which is obviously smaller than the maximum charge Q_m previously indicated. It can then be calculated[2] that when this equilibrium is attained, we have the following mathematical relation between Q_m and Q_s:

$$T_f = \frac{Q_s}{Q_m} = 1 + \frac{F_i}{L_p} - \sqrt{\left(1 + \frac{F_i}{L_p}\right)^2 - 1}$$

in which:

F_i—is the function of the ionic field, and

L_p—is a leakage constant for the particle.

The order of magnitude of the fraction F_i/L_p is $10^{14}/R_p$ where R_p is the equivalent total resistance of the particle. For all intents and purposes, this fraction is very small and tends toward zero for a non-conductor, but is very large and tends toward infinity for a conductor. As a result, the ratio T_f tends toward one for a perfect non-conductor and toward zero for a perfect conductor. While for a conductor it is obvious that the steady state charge will be but a very small fraction of Q_m, for a non-conductor having the ratio F_i/L_p equal to one, for example, we would have $Q_s = 0.268 Q_m$ (Fraas classifies as non-conductors any particles of resistance greater than 10^{13}).[3] It can also be similarly calculated that the time required to achieve a steady state charge on a particle is virtually nil for any kind of particle. Thus the

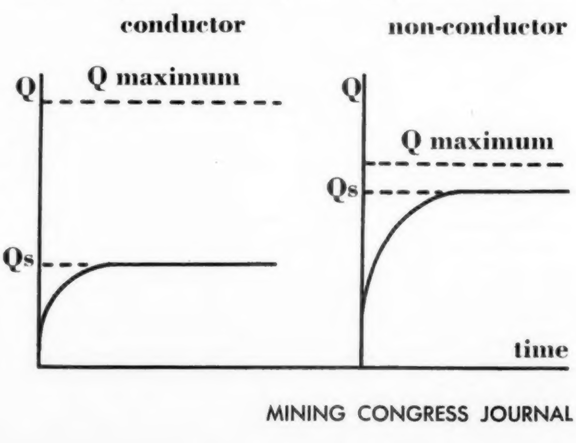

Fig. 3. Steady-state charge on conductor a n d, non-conductor particles

process of achieving a steady state charge on a particle is clearly represented by charge on a conductor or non-conductor as shown in figure 3.

For practical purposes we can consequently state that any particle in contact with a grounded plate and submitted to ion bombardment, will instantaneously achieve a steady state charge of a polarity opposite to that of the plate, whether the particle be a conductor or a non-conductor. Further, under given electrical conditions, the ratio Q_s/Q_m will be only dependent on the resistance of the particle. This charge, greater for a non-conductor than for a conductor, would be nil for a perfect conductor.

Static Field Operation

Also of great interest, if we are to fully understand the mechanics of high tension separation, is the behavior of a particle, charged by ion bombardment, on entering a static field. Let us consider what happens when a charged particle in contact with a grounded plate moves out of the ionic charging field into a purely static field.

The particle, for all intents and purposes, is then lying on one of the plates of a condenser (in the case of our figure 2, the positively charged plate). Mora indicated that in that situation, a non-conductor particle having no electrical contact with the plate will not acquire any net charge, while a conductor particle will acquire (by conduction on its surface) a net charge of the polarity of the plate after a certain time. This net charge due to conductive induction is equal to:

$$Q_n = C_pV(1 - e^{-t/R_pC_p})$$

in which C_p is the capacitance of the particle; R_p, its equivalent total resistance; and V, the voltage differential.

In other words, while a perfect non-conductor particle will go through the static field unaffected, the conductor particle, if it had previously acquired a net charge Q_s (of opposite polarity to the plate), will progressively see this charge decay, then reverse its polarity when Q_n becomes quantitatively equal to Q_s, and increase until it has attained the charge density of the plate.

This brings us to the important concept of charge reversal (figure 6) for a conductor particle traveling in a combined system of ionic and static fields. The calculation of the time T_r at which this reversal of the charge will occur can then be made by re-

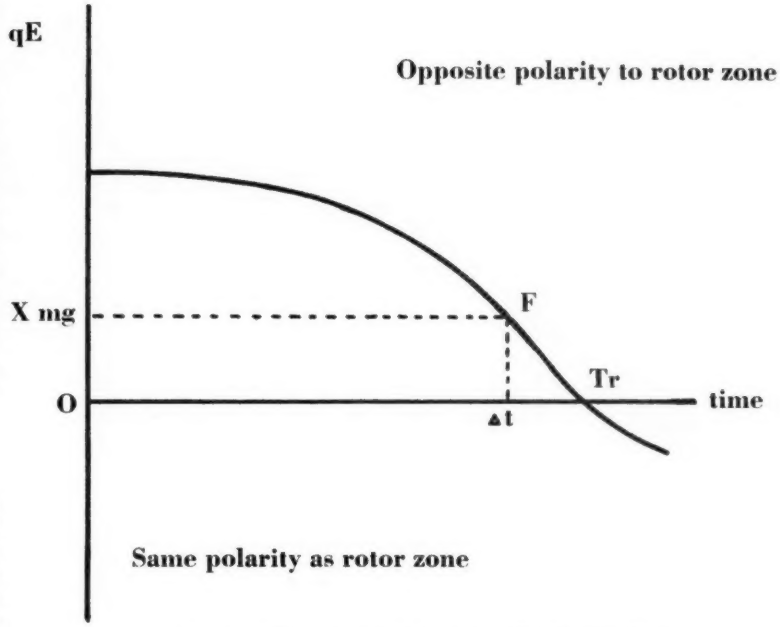

Fig. 4. Lifting phenomenon in relation to retention time on plate

solving for t the equation: $Q_n = Q_s$ which gives:

$$T_r = C\, m\, a\, f\, R_p \, Log \frac{1}{1 - 10^{-2} \frac{E_i}{E_s} T_f}$$

where: C is a constant; m, a clearance correction of value comprised between one and four; f, a shape factor, smaller than one for oblate particles, and bigger than one for prolate ones (f is of the order of two for $c/a = 5$).

From this it results that flaky particles will reverse their charge more rapidly than elongated ones, which is understandable because they offer relatively much more surface contact with the plate from which they derive their new charge. For a perfect conductor, T_f being practically equal to zero, the reversal time becomes nil; but for a poor conductor, the value of T_f being appreciable, the reversal time may take a non-negligible value.

From this, it results that a non-conductor, which has previously acquired a charge Q_s of polarity opposite to the plate, will remain attracted to the plate and its charge will never be reversed. For a conductor, the charge after reversal will continue to increase following an exponential function of time until it has attained the charge density of the plate. Electrical forces then increasing may well reach a point where they will outbalance the force of gravity, and when this condition is attained, the conductor will be lifted from the plate (figure 4).

Principles of Operation of High Tension Machines

The preceding phenomena, which we have tried to explain for the purpose of understanding the elementary principles of operation of a high tension machine, are by no means the only ones involved. Among others, we have overlooked the case of mineralogically mixed particles, and also the problem of particle-particle contact, which is much more complex, and complicates the phenomena in a thick layer of particles. But all these satellite problems do not appreciably affect our basic understanding in its broad scope.

For our expose, we will take a machine of the Lurgi type which uses distinctly separated electrodes for ionic and static field production. This machine, schematically shown in figure 5, consists essentially of a rotating drum or rotor on which the finely crushed ore to be separated is fed at a constant rate. The rotor, which is grounded, rotates at a pre-determined constant speed, while in front of it are located, in prescribed positions, an ionic electrode or ionizer (I), source of the corona field, and a rounded or deviation electrode (S), source of the static field.

Between the electrodes and the rotor, a high d-c potential (over 30 kv) is maintained. Two splitters on the resultant stream of particles coming from the electric fields separate a concentrate, a tailing, and a middling product which must be retreated. It is

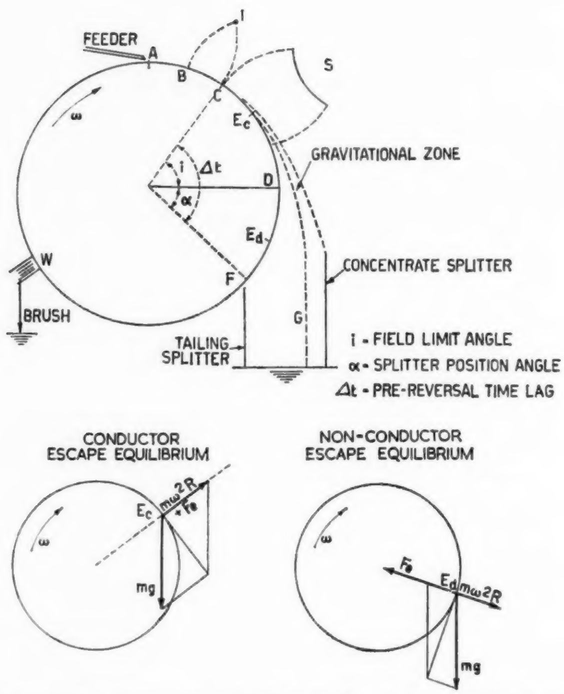

Fig. 5. Schematic Lurgi-type separator and particle escape equilibrium

the relative proportion of this middling in a separation which characterizes the effectiveness of a separator and is the all-important quality which differentiates the separators of different makes available to the mineral dressing engineer.

Two Kinds of Middlings Produced

Let us now analyze what happens when the machine operates. With regular rotor operating speeds, the centrifugal force acting on a mineral particle may be from six to ten times the force of gravity. Consequently, were there no electrical field between electrodes and rotor, the sheet of ore would find a trajectory leaving the rotor from the top and spreading inside a "gravitational zone" (see figure 5) as the result of air resistance on the differently sized particles. If the feed was air-classified, this sheet of ore would be thinly spread.

In the case of figure 5, the concentrate splitter is set so as to just deflect the top layer of the ore stream in the gravitational zone, while the tailing splitter is set so as to separate a tailing low enough in grade to allow a satisfactory metallurgical recovery. Under these conditions of rotor speed and splitter positions, when the machine is operating normally under electrical tension to effect a separation, we will recover particles of conductor minerals to the right of the concentrate splitter. To the left of the tailing splitter, most of the non-conductor particles will remain stuck to the rotor until brushed out by the grounded brush (made of a conductive material).

Between the two splitters, the middlings that are recovered are of two origins, and it is very important to clarify this point. For this, assume that we have an imaginary splitter G, which is set to just clear the bottom layer of the ore spread in the "gravitational zone;" we could then separate two different kinds of middlings as follows:

a) Gravitational middlings between splitter G and concentrate splitter, and:
b) Ionically charged middlings between splitter G and tailing splitter.

Products of Electrostatic Separation

We now have for our discussion four different products which are of interest to study carefully:

1) Concentrates: All the mineral particles recovered to the right of the concentrate splitter, *have obviously been lifted* from their normal trajectory. Consequently they are only good conductors, as only conductors can be lifted, and they have had time to reverse their ionic charge while still above the horizontal point D of the rotor.

2) Gravitational middlings: The mineral grains in this group have apparently gone through the machine entirely unaffected; they are not middlings in the ore dressing sense of the term, but truly untreated material which *statistically* has not been influenced by the fields.

3) Ionically charged middlings: All the particles recovered in that zone have been detached from the rotor by the effect of the centrifugal force overcoming the attraction of the electric force which was pinning them to the rotor. In other words all these middling particles, *which are true electrical middlings*, were still charged with an opposite polarity to the rotor when they reached their escape position from the rotor. The conductors in these middlings were still negatively charged and consequently they either had not yet reversed their charge or had gone statistically unaffected through the static field.

4) Tailings: All particles still pinned to the rotor after passing the tailing splitter are mostly non-conductors and some ionic middlings whose loss is accepted within the requirements of the desired recovery.

For the continuation of this discussion, it is interesting to know the order of magnitude prevalent for the distribution of conductors and non-conductors between the preceding four separated products. The following table indicates this distribution for an iron ore (mostly specular hematite and some magnetite) assaying between 35 percent and 40 percent Fe, that was treated in a high tension separator of medium effectiveness:

Product	% Distribution of: Conductors	Non-conductors
Concentrates	56.2	1.0
Gravimetric middlings	28.0	2.6
Ionic middlings	15.0	7.8
Tailings	0.8	88.6

We know that a non-conductor adheres firmly to the rotor because of the charge it receives in the ionic field, while a conductor is lifted because of the conductive induction charge it acquires in the static field. From the figures of the preceding table, we can see that the ionic field is extremely effective as there is only a small percentage (2.6 percent) of non-conductors which have gone statistically unaffected by the ionic field and have reported as gravimetric middlings.

Loss of Middlings in Tailings

The picture is somewhat different for the conductors, and if it can be easily seen that there will be little difficulty in obtaining a high grade concentrate, it is also apparent that a good recovery will depend largely on the effectiveness of the machine itself. This recovery is essentially affected by the conductor particles (ionic middlings) whose loss has to be accepted in the tailings.

As we have seen, the last conductors which fail to be rejected to the tailings have escaped at point F in figure 5 at a time when the electrical force (resulting from their ionic charging) is still many times larger than their gravity (see figure 6).

It is easy to demonstrate that the following relation:

$$i + a = 57.3\, K_c \frac{\Delta t}{\sqrt{R}}$$

exists between: i, the fields limit angle; a, the tailing splitter positioning angle (both in degrees); Δt, the pre-reversal time lag (in seconds); and R, the radius of the rotor (in cm); with K_c being a constant, dependent upon the minerals associations and the centrifugal force acting on the particles, whose order of magnitude for certain iron ores is 90.

For obvious practical reasons, the sum $i + a$ should not exceed 100°, which gives us the following condition that the rotor radius must satisfy to give an acceptable metallurgical recovery:

$$R > 0.328\, K_c^2\, \Delta t^2$$

For the iron ores previously mentioned, where Δt is of the order of 1/13 second, then $R > 15.7$ cm. In other words, in order to obtain satisfactory recovery on ores having the preceding characteristics, the separator should have a rotor of no less than 12.5 in. diam.

Rotor Diameter Tailored to Ore Treated

As long as the use of high tension separation was confined to the beneficiation of beach sands, minerals for which the order of magnitude of Δt was 1/50 second or less, and the centrifugal force constant K_c could even be greater than 90, the old six in. rotor machines were completely satisfactory. However, since our success in treating iron ores, high tension may well find more and more applications in the general mineral beneficiation field. It therefore becomes apparent that the diameter of the rotor of the machines will have to be exactly tailored to the ore treated and the exact high tension characteristics K_c and Δt of the ore ascertained before the rotor size to be used can be determined.

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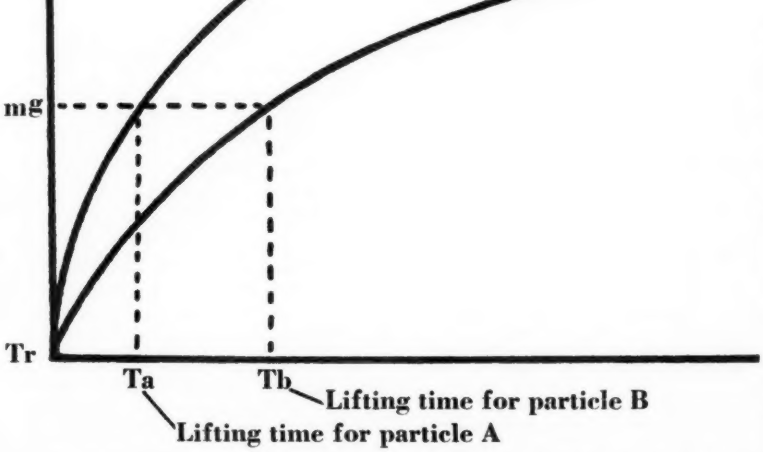

Fig. 6. Evaluation of the electric force acting on a conductor in the static field

EXPERIENCE WITH A-C-MINING

(Continued from page 54)

pany has made it a practice in its mine to establish adequate frame grounding on both primary and secondary circuits. It has never mechanically connected its high voltage grounds with low voltage grounds. Ground conductor is maintained at least equal in size to the conductors of the circuit for which it supplies ground protection. In case of ground relay failure during a ground fault the company wants the ground conductor to outlast any of the power conductors. This practice has paid off on several occasions.

It is true that with the advent of monitored ground circuits, and the use of resistance and/or impedance limitation of line to ground fault current, adequate protection may be obtained without the use of such large size ground conductors. Management, however, does not feel that it would be economical to discard all of its multiple conductor cables to accomplish this more modern system. This will be considered when and if the company is compelled to start a major cable replacement program. There has been no operating time loss of consequence due to electrical failures. It would serve no good purpose to make a detailed comparison of the company's a-c operating experience with its d-c operating experience. The foregoing outline of maintenance experience speaks for itself.

In justification of the decision to operate on a-c power alone, the company likes to cite the quaint expression of opinion made by one of its colored miners in the early days of its a-c operating experience—"There's one thing about that there circulating current, it either is or it ain't."

In concluding, the writer would like to predict that as experiences such as Union Carbide's with a-c operation becomes well publicized, more and more mines will be converted from d-c to a-c. In the future new installations will be almost exclusively a-c. The ten-year period of the "fabulous 60's" might well see a-c assume the role for which Union Carbide feels it is so eminently suited. The writer should also like to propose the use of time proven diesel-powered motive units where track haulage is used. This will finally remove from the coal mines the need for uninsulated electric conductors. With their removal from mines go one of the most common sources of electric shock and one of the most prolific ignition sources of coal mine fires and explosions.

PERSONNEL EVALUATION AND SELECTION

It is almost impossible to do a sensible job of selecting and evaluating personnel without knowing yourself

By JOHN N. CRICHTON
Executive Vice President
Johnstown Coal & Coke Co.

A sound program of "Personnel Evaluation and Selection" is an essential business tool in developing executive and supervisory talent.

All of us are concerned with improving our companies' performance. By working for improved performance, we must have the proper personnel evaluation and selection. By having this proper selection, we are providing our company with a reservoir of executives capable of assuming greater responsibilities when new opportunities arise. Therefore, personnel evaluation and selection must be used as a development tool. There are many methods and elaborate systems that can be employed, but the first step in any company is to get all the employes in the process. All of them should be working some part of every day on personnel evaluation.

Promote From Within or Go Outside for Applicants?

When a vacancy occurs, there is, of course, an opportunity to strengthen the management team through selection of the best-qualified candidate. Practically every company recognizes this.

Should you promote from within or go outside for applicants? On first consideration, it might seem that this would be the first question to answer. Actually it is the last. You cannot know how qualified anyone is until you first know or decide what you want. Once you know what you want, you can examine the records of the people currently in the group and see how nearly they come to meeting the requirements. Then you must match the employe to the job. If you decide you want to go outside, you will know how much screening you want the personnel department to do, and how much of the selection process you will conduct yourself.

This working out a selection plan is a development process since it compels the individual to think about the organization and its requirements and the qualities a good supervisor will need.

Suppose, for example, one fellow listed qualifications in general terms, such as:

(1) Administrative ability
(2) Dependability
(3) An awareness of the supervisor's responsibility to management and to the employes
(4) Temperamental fitness to lead and supervise others
(5) Willingness to deal with people
(6) Knowledge of the job

Then his superior's first question might be: "What is temperamental fitness to lead and supervise others?" The man might not be prepared to answer, and the question might force him to think intensively about the matter—and in the process, to consider his own past conduct, as well as the conduct he expects from his subordinates.

You Must First Evaluate and Appraise Yourself

You might say this is a method to force yourself to "self-appraisal." In order to properly evaluate, select, or appraise, you must first spend some time soul-searching—you must evaluate and appraise yourself.

In self-appraisal one should ask:
(1) What are my objectives? (Currently and in the future)
(2) What part of my job do I do well? What do I do wrong?
(3) What do I enjoy? What do I dislike?
(4) What don't I like in other people?

Another way to help appraise yourself is to listen to your wife, as difficult as it may be. She knows you better than anyone else.

If you answer these questions by taking a sheet of paper and drawing a line down the middle and listing your attributes on one side and your failings on the other, you are a good step ahead in learning to evaluate and select other people.

Another important item to remem-

ber is that every time a vacancy occurs and someone is chosen—either from within or from outside—the people who expected or hoped to be promoted to the job, but lost out in the race, present a problem. Handled wisely, the situation can provide another special opportunity for development; ignored or handled ineptly, it can disrupt morale and performance for a long time to come.

Push the Man Ahead and Drag a Man Behind

It was said at an A. M. A. management course that for an individual to be worthwhile to his organization, he should be "pushing the man ahead of him and, at the same time, dragging a man behind him." This is something to think about when evaluating individuals.

In order to drag a man behind you, it is necessary to spend much time on training. The most expensive person on a payroll is the half-trained employe. His production lags, his morale is low, and he is not satisfied. The ideal employe knows his work and how to do it. He has a pretty good idea of why he does what.

A well organized training program starts with the company president and reaches down to the lowest worker. There are things the president needs to know, and there are things he needs to teach others. The same holds for each supervisor. Training should begin the moment a new employe walks in the door and must continue until he walks out.

If each employe or supervisor feels the company wants him to think and help the man under him, the employes will be better and the company will naturally be an improved company. And the selection of employes will be made easier.

By spending a little time each day with each man under them, section foremen or supervisors of any type can learn to know the employe a great deal better. This makes for effective leadership. Effective leadership is no different from effective living. The effective leader seeks to grow, to discover and put into use his full potentialities. He seeks these for himself and simultaneously strives to create relationships where others can seek these processes of growth, should they so desire.

It is not necessary to be a part of a small company to know your employes if everyone is working to improve and help the fellow under him. Each section foreman or supervisor is actually president of his own little company. There is an investment of many hundreds of thousands of dollars on his section to work with. He has the individuals to do the job. To get the job done properly he must use the necessary men on the job. He must evaluate. To evaluate he has to learn to know his people. He must train them to improve his section. His immediate supervisor must spend some time trying to help him improve. It is a vicious cycle.

The ideal situation is to have only about six people reporting to you. With this set-up you are able to know your employes better and what they are doing, and you are able to work close enough with them to be helpful. We in the coal industry tend to get lost in tonnage, costs, sales, etc., and we do not give enough consideration to the other fellow and how we can help him. By helping him we will be helping our company.

A System of Continuing Education Must Be Instituted

No matter how well you select and evaluate your employes, there must be some sort of continuing education and desire to change. The desire to improve must come from the man above you. Appraising and evaluating employes is also a continuing process. It begins when the man applies for a job and continues throughout his stay with the company. You must make a just and honest measure of the employe's actual and potential contribution to the company. The measurement—and the responsibility for its accuracy—rest largely with the supervisor.

If you do the proper job of training your employes, your job of evaluating and selecting people will be a great deal easier. You will know the individuals much better if you have spent time in training them. You will have many more people to choose from for the vacancy you are selecting for.

In summary, no fancy plans are necessary to have proper "Personnel Evaluation and Selection," or proper appraisal, but you must have spent some time in self-appraisal. It is almost impossible to do a sensible job of selecting and evaluating without knowing yourself. In addition, in order to continue a proper evaluation and selection process, you must have a selection plan. Also, a system of continuing education must be instituted so that the best type of employe will be available at the time of selection.

The three items above help to create a by-product of improved morale as all people would like to know "where they stand."

Therefore, in helping to make each small or large company a good place in which to work—a place of cooperation, of joint pride, of individual fulfillment—proper personnel evaluation and selection is an essential contribution to the American way of life.

HOW SHALL WE TURN THE WHEELS?

(Continued from page 40)

consideration. The power source to some degree dictates the means to be used to propel the wheels; therefore, manufacturers are keeping all channels open in their development work in order to avail themselves of the latest advances in this technology.

Experience with current production high-output diesel engines for electric drives indicates too short a life. This is believed to be caused by the ability of the operator to draw full power utilization from the engine. This has been observed to a degree with torque converters and power-shifted transmissions in heavy hauling units. The engine people have much work yet to do to give more dependable engine hours.

Another element that enters the picture, of course, is the tire. Much work is, and has been, going on with the tire suppliers to keep pace with the increasing loads and speeds with much more work needing to be done.

It appears that this problem, "How Shall We Turn the Wheels?", is one of many facets: engines, transmissions, hydraulic motors, pumps, electric generators and motors, final gear trains, wheels, tires, suspensions, lightweight high strength alloy steels for load carrying members—*all* must be blended together. Each must receive its proper attention.

No One Drive Is Suitable for All Sizes and Types of Vehicles

Work continues at a fast pace on the full mechanical drive and this has proven fruitful also. The conclusion at this time, therefore, is that no one drive is completely suitable for all sizes and types of vehicles and machines. Rather, it is believed that there is and will continue to be a most suitable drive for various classes of vehicles in size, weight, cost and purpose for their use. Manufacturers are keeping open all three approaches—full mechanical, full hydraulic, full electric and various combinations of each and all.

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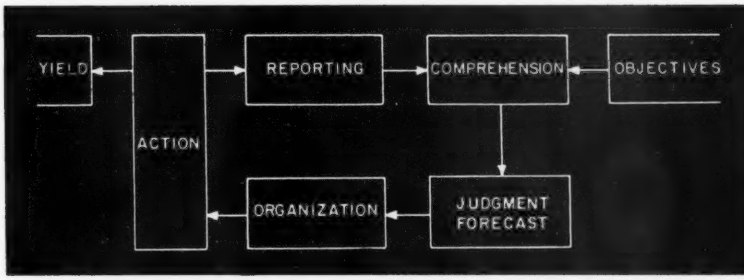
Computers in the Mining Management System



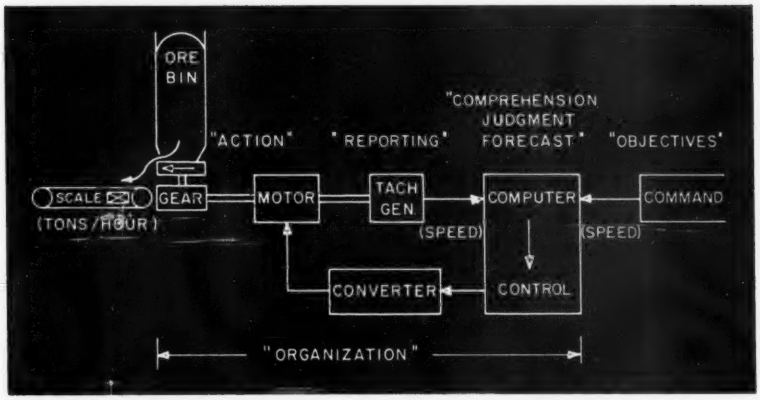


Fig. 1. (Top) Management decision closed loop. Fig. 2. (Bottom) Management equipment closed loop

Computers make administration more effective by relieving humans of a tremendous burden of detail

By WALTER H. SCHWEDES
Senior Engineer—Mining
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ANY business venture's operating success is related primarily to successful management decisions, made and carried out in an orderly and systematic fashion and environment. To appraise the use of computers as management supplements in mining, let us first identify those factors on which a successful decision depends. We may then have some bench marks or ground rules by which we can:

1) **Evaluate our present corporate structure as an efficient working entity or well designed system.**
2) **Redesign our corporate system, if necessary.**
3) **Judge the quality and performance of modern day management tools, like computers.**
4) **Apply this management equipment usefully.**
5) **Evaluate its worth to our system's future.**
6) **Define a timetable of action.**

Successful management decision making, in the ideal sense, is a dynamic continuous process as indicated in figure 1. It is truly "closed loop" control, even though at certain levels there may be time lags in communication.

Reporting must be accurate, thorough, and timely.

Comprehension is the integration into a larger whole of the various and many pieces of reported data, taken from different points in time and space—the building up of a coherent picture of something that may not be completely observed at one glance. It involves highly developed short and long term memories, built in coding systems derived from past experience, and the ability to marshal the new and the old coded knowledge in a systematic way.

Judgment is the capability to reason—to mentally solve complex, often rather vague, and simultaneous equations to an acceptable degree of accuracy.

Forecast is the ability to project that equation solving with new data, assumed to be representative of the future.

Organization is the structure of an efficient working system, designed for obedient action, automatic instruction translation, rapid communication, stability, long life, and reporting.

In humans there are also other vital requisites like: Adaptation to business and social environments, orientation to work, objectivity, maturity, timeliness, and stamina.

State of the Management System

This study of management systems has received an enormous amount of attention. It would seem now that the present "state of the art" calls for action. What, then, is the present "state of the art" of management tools or equipment?

While corporate systems were being studied and developed from the top down, equipment systems were being developed from the bottom up.

Business machines grew from the cash register and desk calculator to modern electrical systems for handling costs, payrolls, inventories, and taxes at high speed and less cost.

Production machines were equipped with electric motor drives, designed to run and stop safely. Some were made manually adjustable. Then obedient action was vastly improved by the development of the regulating system. The burden of command was eased.

Figure 2 shows a typical speed regulator for an ore table feeder drive. Here the command is in the unit "speed."

By simply reporting the action back to the computer via a scale instead of a speed measuring device, the

unit of command can be the more useful "tons per hour," and a process machine with drive included has been made part of the system. And so on up the technical chain of command. Not only, then, are management systems ready for action, but so are the building blocks of equipment.

Now compare figure 2 with figure 1. Note that both the management decision and equipment closed loops are functionally identical! Their basic designs are one and the same. They're compatible and can be put together into an equipped management system. The specific choice of equipment will depend on the specific management job to be done.

First, let us look at the jobs to be done, then at the equipment, and put them together in an equipped management system.

Let us look again at the management closed loop for bench marks in designing a manageable system (figure 3). We must

1) **State clearly the short and long range specific *objectives* of the system.**
2) **Define functionally the *actions* necessary for accomplishments.**
3) **Construct the technical and the business *organizations* for specific action.**
4) **Instruct the organization to *report* concisely and on time.**
5) **Develop the coding, the memory, and the integrating techniques that afford *comprehension* of reported data.**
6) **Explore the mathematical relationships that convert old, present, and new data into *judgment* and *forecast* in the human brain. The equations *are there* to be brought out, written down, improved on, and used systematically.**

Example of Mining Management System

In figure 4 we have constructed a mining management system from the top to the bottom of command. For illustration purposes, only the technical system has been detailed and that for copper.

Note that the production of copper from ore has been broken up into separately manageable islands, each called a *process.* Those shown are arbitrary. They would have some natural boundaries like a change in flow state, a storage, or a change in process action. Each would be capable of receiving a business balanced command from above, of reporting back, and of further command down to its parts, called the *process machines.*

Each process machine, in turn, may have several *drives.* The ore rate feeder may have an adjustable table feeder drive to hold constant weight on a scale for weight accuracy *plus* an adjustable feed belt drive for rate feeding the grinding process. Or a rake classifier will have an adjustable speed rake drive plus an adjustable water valve drive. And so on.

The function of each of the several drives of a process machine may or may not be related to others and hence under common command at the process machine. Instead each drive, though affecting others, may receive its command at the process island level or even at the production department level for the business balanced benefit of the whole.

This then is the management sys-

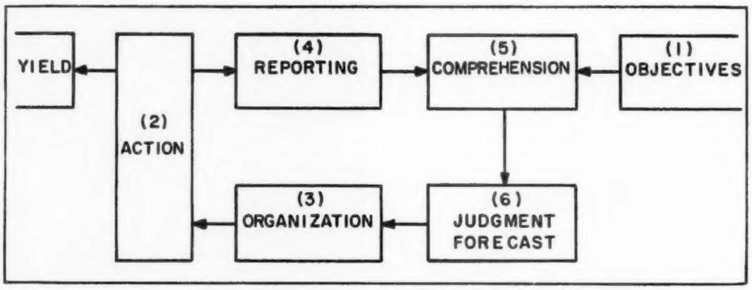


Fig. 3. Management system closed loop

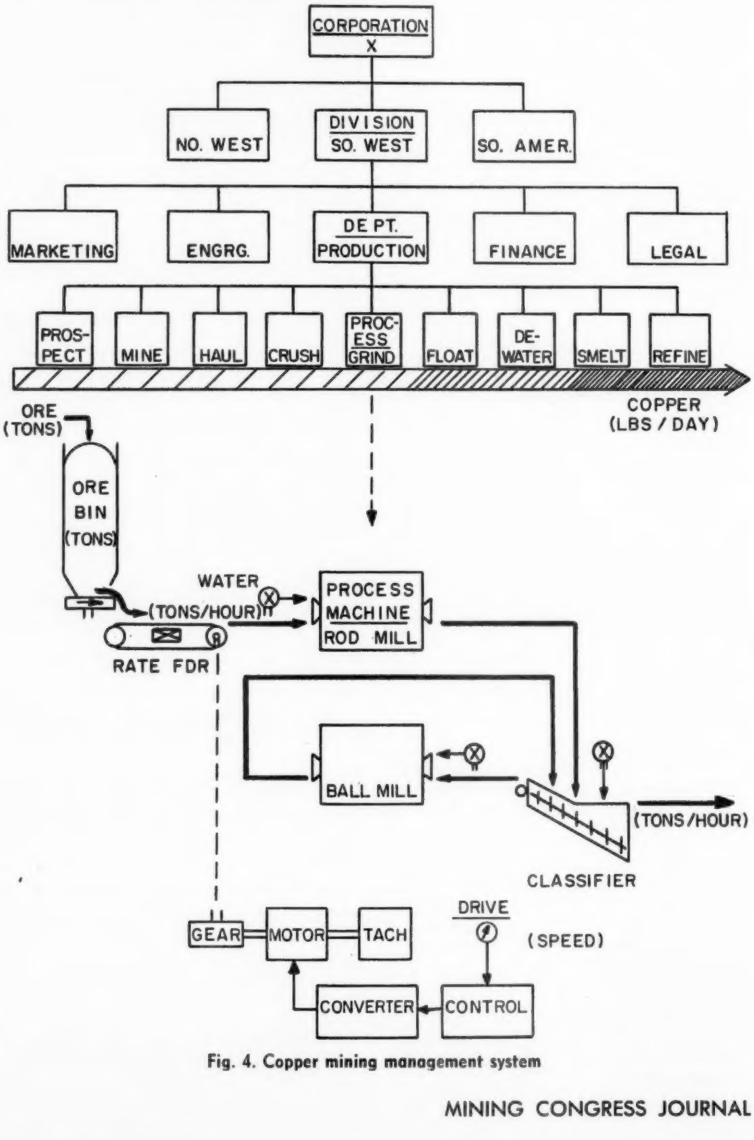


Fig. 4. Copper mining management system

CORPORATION DIVISION DEPARTMENT	PROCESS MACHINE DRIVE
BUSINESS OBJECTIVES	PRODUCT OBJECTIVES
BALANCED INTERESTS	SPECIFIC INTERESTS
BUSINESS BASED	TIME BASED
PREDICTIVE	ADAPTIVE
LARGE FILING	LIMITED FILING
COMMANDING	OBEDIENT

Fig. 5. Functional description of computer types

tem, from the objectives given the corporation by its owners clear down to the motion command of an individual drive.

Sensors and Computers Defined

For this management system there is already available a wide assortment of equipment. For simple identification, any device that directly reports a measurement let us call a "sensor." And any device that adds the management functions of coding, memory, comparing, or any arithmetic, before reporting let us call a "computer." Both sensors and computers can be either analog or digital to suit the job to be done.

Analog sensors measure and report in continuous proportional values, like the speedometer on a car or the tachometer on a drive. The majority of sensors are analog.

Digital sensors count and report in discontinuous pulses, like a counter of traffic or of ladles.

Analog computers code, remember, and do their arithmetic by comparing proportional measurements, like a slide rule. Common applications include obeying the speed or torque command to a drive, flow command to a valve, or the less important commands to a process machine or process. Since comparisons are made with devices in circuits, there is a practical and economic limit to the assignment of coding, memory and complex arithmetic.

Digital computers code, remember, and do their arithmetic by counting pulses, like the abacus. Simple codes are built in so that pulses represent numbers and instructions. With pulse counting extremely fast and pulse storage extremely compact, this computer can be given very complex and cumbersome technical and business assignments.

Experience has already shown that sensor and computer electric hardware, particularly those with static parts, is demonstrating amazing reliability.

Intersystem communication by electricity is also efficient, simple and swift. Sensors with electric outputs and computers with electric inputs and outputs can be applied to their jobs and integrated by electric wire, the schematic diagram for which can be our management system chart.

Automatic language translation equipment is required, since each job assignment has its own language, that is, the units of command and report for that particular drive, process or cost. It is usually built into the sensor or computer, converting direct measurements into electric signals, converting from analog to digital or back again as required, and converting from human to system and back in any units, form and time found appropriate.

Computers Fall into Two Broad Groups

The mining industry requires some 50 different sensors, assigned to some physical measure, motion, flow, or property thereof.

Computers fall functionally into two broad groups and are designed accordingly. Figure 5 generalizes that the *corporation, division,* and *department computer* would be instructed with business objectives, should be capable of forecast, and would conclude in the best balanced interests of the business in primary units of cost, profit, or growth. The *process, machine,* or *drive computer* would be instructed with product objectives, need not predict except for stability, and would conclude in the specific interests of its job assignment in time based units of quantity or quality.

Let us start with the *drives* at the bottom of figure 6, for first of all we need obedient action and reporting from those that are to be adjusted for control of the machine, the process, or the production of copper. The drive must be equipped for adjustment as needed. To it we add an analog computer, usually calling the result a regulator. We have closed our first loop in units of speed, as we will close others in units of flow.

Command of the feeder drive comes from a "through-put" computer in units of tons per hour. A process loop has been closed.

Other grinding process loops can be closed in units of tons, specific gravity, pulp density, or particle size. These computers, indicated on figure 6 by small circles, may be of the analog *process machine* type, often called controllers. However, there are two important suitability factors.

1) **In steady state performance all of these grinding process machines may be so interdependent that all of the cross relationships cannot be adequately built into the computations for each.**
2) **In dynamic performance of systems with major outer loops and a number of minor or inner loops instability is a real problem. We have all heard of unaccountable surging, sudden loss of grind or through-put.**

Either of these reasons is enough to suggest that certain of the process machine computers become part of the grinding *process* computer. And it is possible, then, that the latter's job assignment is complex enough to warrant choice of the digital type. We should give our production and engineering people all the help and encouragement we can, so they can derive these technical answers promptly.

Functions of Departmental Computers

The production department computer will integrate the technologies of all the process islands. It will have the two-way communication of report and command with them. Its basic units will be copper quantity, quality, and cost. This is probably the first computer level where costs should enter. It would be far too cumbersome to equip or instruct each process island, machine, or drive computer with all of the interrelated costs of the others. Complexity will require this to be digital.

The engineering department computer would also be digital, because of the enormous chore in numbers in appraising ore bodies and their values, in planning the vast movements of ore and waste and their costs, and in the construction of transport and plant.

The marketing and finance department computers would most certainly be digital because payrolls, costs, taxes, prices, and finance reports are always wanted in numbers and more often in some areas not continuously but averaged with time.

The legal department would not need a computer, but in many instances will require facts that can be quickly supplied from computers in other departments or central claim and patent offices.

The division computer will integrate the departments into a business entity. Units of performance here are profit, service, growth, soundness, and influence on environment. Local and domestic competition and political factors, market surveys, technology changes, reserves, and long range plans can be comprehended, judged, and forecast better and faster. A customer's order can be taken, handled, accounted for, shipped, and billed automatically and rapidly.

The corporate computer shown would integrate the divisions and include those factors influenced by global markets, competition, transport conditions, and politics. It would report directly to management, the tax collectors, and the owners.

Burden of Detail Left to Machines

When properly instructed, computers will do a good job of decision making because they can be equipped to receive and code vast amounts of complex data, store for any length of time, calculate accurately and consistently either known or assumed data, report concisely on schedule or on demand and do all this at fantastic rates. They can be instructed to adapt their operations to any change in environment that can be measured, and have built-in management qualities of objectivity, stamina, and the ability to make a timely decision.

Computers will not replace us as managers. We will be vitally active in the system to monitor its performance of our objectives, to make the important decisions, to continuously research it for product, profit, or other innovation, and finally to maintain that corporate ambient in which humans will be even harder at work.

But when computers are part of the management system, they will remove a tremendous and continuous burden of detail, making decision and administration the most effective. In short, they and their peripheral equipment in the completed system will bring *control* of the business *back into the hands of management.* This is true automation.

It is certain that the system cannot be constructed overnight. There will be experimenting to prove the true principles of the technologies involved, to derive the mathematics, to modify certain machines and drives, to place the sensors. But at all times there must be aggressive advancement toward *the system. Top management* must dynamically and personally sponsor this system construction to assure its progress.

Relaxed, piece meal installation of controls or devices, left up to others under the guise of quality control, will not do. In fact it is dangerous. For if continued, whole groups of employees will acquire a vested interest in partial systems and management will find itself faced with even greater resistance to change. This is a strong prime mover.

Performance Measured by Rate of Progress

The challenge of competition both domestic and foreign is another prime mover. The Japanese are teaching us new tricks in production. They have too long a row to hoe to lean on cheap labor alone. Their labor won't stay that cheap either. The last international technical conference on automatic controls was held in the Soviet Union, where ideology and preplanning are daily stimulants. Consider the great number of technical papers we have noticed lately, translated from the Russian!

Strength of position and growth in a world wide industry no longer have only long term meaning. Decades have become years and months. Our performance is measured not just in progress but *rate* of progress. The computer equipped management system, just described, will give us that built-in high speed operations research to keep us accelerating.

A reputation for this has real value, too. In many product markets today acceptable quality at an acceptable price can be had from a number of sources. The reputation for being a "leader" and for prompt and integrated service can easily be the reasons for placement of orders.

Top management alone must make

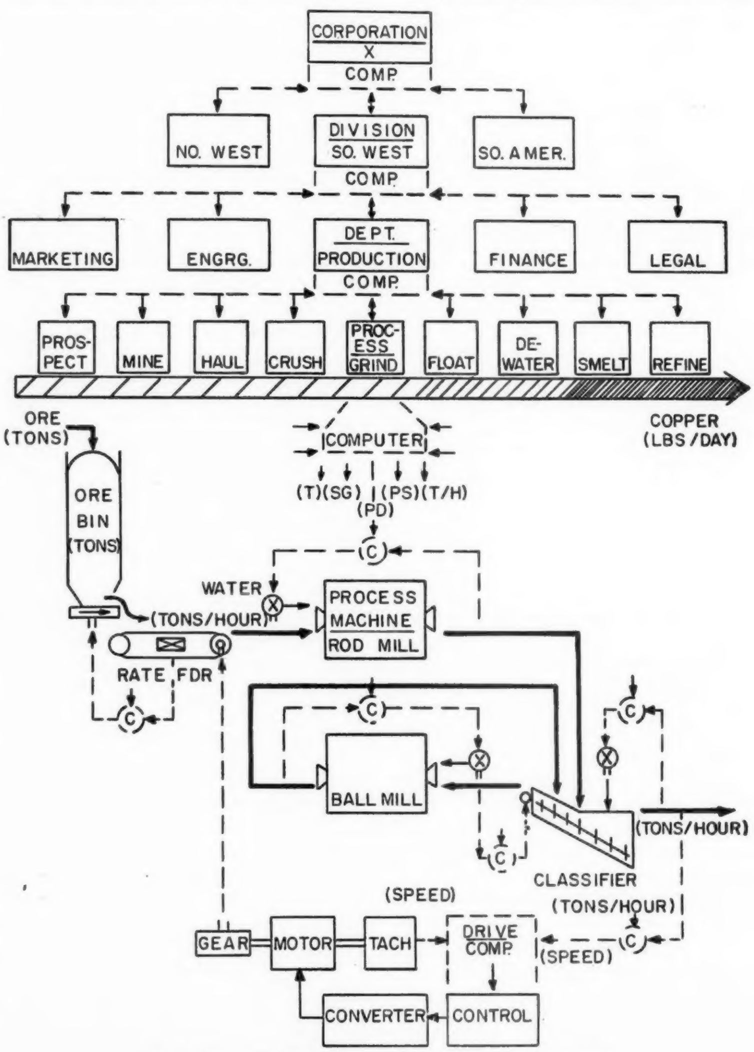


Fig. 6. Computers in the copper mining management system

this first big decision: To command and finance this action for strength and growth.

Criteria for Evaluating System

We, the management, now have the reasons, the media, the plan and the decision for action. We have already accepted a challenge that is difficult, costly, and lengthy.

As we construct the details of our management system, each decision to "close a loop" will be based on the questions: Does it fit the total system? Is it feasible? Is it worth it?

Criteria for feasibility and worth are:

1) **This part of my system contributes such value to the whole that a small increase in yield will be of measurable value.**
2) **Its basic actions are or can be understood, even if not now apparent.**
3) **It is subject to disturbances, either random or periodic, which affect the yield. There may be noticeable variations between identical parts in parallel.**
4) **Its basic actions or interactions with other system parts are sufficiently complex and/or of such slow response that the logic of disturbance corrective action is not obvious to the operator, affecting yield.**
5) **It is continuous but so slow to respond to intentional changes that interim periods produce waste or other loss.**
6) **It is discontinuous, so that improper or inaccurate preplanning irrevocably produces waste until the next batch is started.**
7) **It appears to have high labor or other cost content.**
8) **It is subject to yield variations (for any reason) which cannot be directly approached by present management control.**

Now, for a tentative design we can add up the costs of:

1) **Learning the actions and interactions.**
2) **Sensors and computers.**
3) **Installation and interconnections.**
4) **Modification of existing parts.**
5) **Staff services that have changed.**

And the worth/cost ratios will lead us to the decisions to close the system loops.

It is significant, that even if no new equipment is installed, the system study alone may show a tremendous profit from resultant change in business operations.

Wherever the worth/cost ratios are favorable, the system design can be started. Forecasts of performance and stability of the system or its parts are not only feasible but the right way to final design.

Take the diagram of a closed loop, figure 1, again. These are blocks connected by communication. The system designer will have learned language translation. Then he can substitute mathematics for words in the blocks. And he will have learned to measure. He can then fill in the numbers and time lags in each specific block to represent exactly what takes place. Next he can write simultaneous equations for the parallel paths of the block diagram and thus construct the mathematical model of the system.

Now he can solve those equations for performance and stability. Again, he can enlist the aid of computers, analog, digital, or both for time-based performance, and digital for business-based performance.

We, the management, may choose to own this predicting computer, we may use one belonging to someone else, or we may rent one that we may later apply to our equipped system.

Computers Not Restricted to Big Business

We can see, now, the kind of learning job cut out for management. We need mathematically capable persons in our operations research, not only technicians. These persons are special and expensive but they're worth it. For they have true management worth just as do the computers they serve. If we don't have these people and we can possibly do so, we'll go out and hire them, right now. We must have them because they're a permanent part of our management system. With them we'll learn and design—better, faster, at lower cost—and continue to redesign to match our own growth rate. Sooner or later they'll be part of our system.

If we absolutely can't hire them right now, then it's possible we can time-share those in the employ of professional consultants or computer manufacturers, with whom we would make businesslike arrangements.

Mother nature, however, tended to upset us a bit in mining. She did her best, it seems, not to standardize our production problem. We, the owner management, patently have a head start on outsiders because we started our learning long ago and have lived with it for better or for worse. Computer manufacturers could and would catch up. But, when we remember that the learning time is long, we realize that they would expect very businesslike incentives to share for that long a time the special skills hired for progressive product design.

It is not known whether proprietary interest enters the technical picture very seriously. By and large the mining industry has always done an excellent job of sharing with its domestic fellows. In this day of global race it is suspected that we'll share even more with them.

But that ultimate sharing won't prevent us from wanting to get a head start and to stay ahead.

In summary, computers have true management worth. They are a natural part of the management system. They are useful as such in only the well designed system. Only then can the system "recapture" control of the business, influence rate of growth, increase yield in product and profit. Computers are reliable partners in operations research and they are not restricted just to "big" business. It is up to top management to lead the way and to do it soon, for it's your management system that's involved and it must be designed by you and for you.

DRUM HOIST CONVERSION

(Continued from page 51)

with the drum hoist system would accomplish the same thing, however, it would require about a third again as much rope.

From February 1, 1960, to July 1, 1960, the new friction system hoisted 116,227 tons in 24,114 skip trips, giving a skip factor of 4.83 tons and a tread pressure of 258 psi. The friction material groove has increased in depth $\frac{1}{8}$ in. on the skip hoist. Most of this change is due to compression rather than wear since the last few readings have shown no change. The friction material on the cage hoist shows very little change. Although some in the industry would consider our tread pressures quite high, with the present rate of wear, the PVC tread material should last quite awhile.

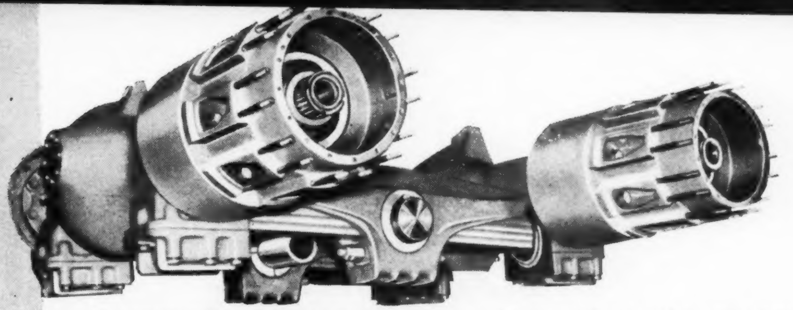
The pull ropes and tail ropes are still in excellent condition.

Still Deeper Hoisting Now Possible

The converted Bristol mine hoists now reach 250 ft deeper, and hoisting capacity has increased some 35 percent. The PVC friction material has thus far given exceptional service and should permit two more 250 ft levels using flattened strand ropes. Locked coil ropes may permit going even deeper.

The increased loads on the hoists and headframe were handled with minor reinforcing and the misaligned shaft has not presented any tail rope problems.


Mack
Mack



Advance Program

1961 COAL SHOW

CLEVELAND, OHIO • MAY 15-18

CLEVELAND will play host May 15-18 to thousands of mining men from all over the world. Their objective will be to capture new ideas and gather up-to-the-minute information on how to cope with today's and tomorrow's industry problems. Focal point of activity will be Cleveland's huge Public Auditorium where the 1961 Coal Show of the American Mining Congress will be held, complete with a giant machinery Exposition and the all-inclusive technical sessions.

The National Program Committee, under the chairmanship of F. S. Elfred, chairman of the board, Peabody Coal Co., has done an outstanding job in setting up a "bread-and-butter" type of program that will emphasize ways and means of reducing costs, raising productivity, achieving greater safety and producing a higher quality product. An examination of the Advance Program, printed on the following pages, will reveal the wide range of important subjects to be discussed. Authoritative speakers will explore the latest advances in deep and strip mining as well as coal preparation and the problems of management and safety. Of particular interest to industrial mineral producers, metal mine operators and strip coal miners will be a special session devoted to cost cutting developments in open pit mining.

● The Exposition, a liberal education in modern mining technology, offers an unequaled opportunity to see and compare all types of mining equipment. More than 225 manufacturers will feature new and better tools that spell continued progress in all phases of coal production. The exhibits will be well staffed with manufacturers' mining specialists, a prime source of information for mining men looking for a better way to do a job.

Nor has the entertainment side been neglected. The big official evening function of the Coal Show—the Coal Miners' Party—will be held on Wednesday evening, May 17. The social highlight of the week, the party will feature a superb dinner, dancing and a lively floor show.

Ladies, of course, are cordially invited to attend the Coal Show and all its activities. They will also want to take full advantage of Cleveland's many interesting sights and fine shops. In addition, three special events have been arranged for them. At a welcoming luncheon, Monday, May 15, Mrs. Ivy Baker Priest, retired Treasurer of the United States, will discuss the Washington scene and give her views on "Women in Government." Tuesday, May 16, a trip has been scheduled to General Electric's famous Lighting Institute at Nela Park for a fascinating demonstration of future lighting trends. Following luncheon, a conducted tour will be made of the "May Show" at the Cleveland Museum of Art. A luncheon at the Shaker Heights Country Club, Wednesday, May 17, will feature a novel presentation by Marthie Bouche of New Orleans, the "Madhatter", showing how to select a hat to fit your personality.

● For Friday, May 19, following the Coal Show, two trips of special interest to mining men have been arranged. One is a visit to the northern terminus of the famous coal pipeline from Cadiz, Ohio—the Eastlake Station of Cleveland Electric Illuminating Co. Visitors will be especially interested in the facilities at the discharge end of the pipeline, where the slurry is dewatered and the fine coal prepared for use under the boilers.

A second trip will include a tour of Republic Steel's Cleveland Works and a scenic cruise down the Cuyahoga River and through the harbor. A first-hand inspection will be made of the ninth largest steel plant in the world, including the ore docks, coke plant, blast furnaces, open hearth furnaces, and the largest continuous strip mill ever built.

Every progressive mining man is constantly looking for a better way to do his job, and there's no better source of new ideas in coal mining than the AMC Coal Show. It provides an excellent refresher course in mining technology—plus a wonderful opportunity to meet old friends and make new ones. So don't delay. Mark May 15-18 on your calendar and make arrangements NOW to attend the industry's big event of the year, the 1961 Coal Show!

Monday, May 15

10:00 A.M. OPENING SESSION

Presiding: R. E. SALVATI, Pres., Island Creek Coal Co., Pres., American Mining Congress

Remarks:

JESSE F. CORE, Vice Pres.—Opers.—Coal, U. S. Steel Corp.; Chairman, Coal Division, American Mining Congress

F. STILLMAN ELFRED, Chr. of the Board, Peabody Coal Co.; Chairman, Program Committee, American Mining Congress

D. E. DAVIDSON, Vice Pres. for Sales, Link-Belt Co.; Chairman, Manufacturers Division, American Mining Congress

ROBERT M. HARDY, JR., Pres., Sunshine Mining Co.; Chairman, Western Division, American Mining Congress

National Fuels Policy—

Office of Coal Research—

Speakers to be announced

A Look at Coal's Future

The next 15 years will be important ones for the coal industry. A student of factors that affect coal's fortunes will analyze current energy developments and their impact on the industry's short-range future.

CHARLES J. POTTER, Pres., Rochester and Pittsburgh Coal Co., Indiana, Pa.

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Tuesday, May 16

9:00 A.M. CONVENTIONAL MINING

Chairman: C. C. CORNELIUS, Exec. Vice Pres., Emerald Coal & Coke Co., Pittsburgh, Pa.

Vice Chairman: VIRGIL A. CURRY, Mgr. of Mines, The Youngstown Mines Corp., Huntington, W. Va.

Conventional Mining in Thin Seams

Concentration on the problems involved in conventional mining 28 to 36-in. coal at Princess Coals has resulted in a rate of productivity that is higher than the national average for underground mines. Developments in mining technology and equipment design, as well as a focusing of attention on preventive maintenance, have made this possible.

CLYDE H. STOREY, Dir. of Indus. Engr., Elkhorn Coal Div., Princess Coals, Inc., David, Ky.

Shooting With Air in Low Coal

Substantial savings in time and shooting costs have been made possible through the introduction of mobile air blasting units. By mounting this equipment on drilling machines, one man now both drills and shoots.

JOE L. MCQUADE, Sr. Exec. Vice Pres., Maust Coal and Coke Corp., Richwood, W. Va.

Maintenance at Moss No. 3

Is it more efficient to have a maintenance man as a regular member of a production crew, or dispatch him to the section from a central underground shop when necessary? This question is being studied at Clinchfield, and will be discussed by the author who will also cover preventive maintenance, maintenance of a.c. equipment and the keeping of maintenance records.

BALLARD TAYLOR, Asst. Supt. of Main., Moss No. 3 Mine, Clinchfield Coal Co., Dante, Va.

Future of Conventional Mining

Conventional mining equipment offers maximum flexibility and a generally unrealized production potential. Where the flexibility is needed, and the production potential can be realized, conventional equipment is still the answer.

JACK MATHESON, Chf. Methods Engr., Island Creek Coal Co., Holden, W. Va.

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9:00 A.M. MANAGEMENT AND COST CONTROLS

Chairman: WHITNEY WARNER, JR., Pres., The Sterling Coal Co., Philadelphia, Pa.

Vice Chairman: RALPH B. DEAN, Controller, The Lorain Coal & Dock Co., Columbus, Ohio

Profitable Control of Production and Transportation Through Operations Research

Determining the relationship of profits to the choice of mine sites and transportation routes is often complex and difficult. Linear programming techniques offer interesting possibilities for handling these problems more effectively. With them it is possible to evaluate quickly and accurately the profit consequences of changes in customer requirements, operating costs and taxes, transportation costs, and mine capacities.

DAVID B. HERTZ, Principal in Charge of Opers. Research, New York, N. Y., and

NORMAN O. OLSON, Partner, Arthur Andersen & Co., St. Louis, Mo.

Control of Supply Costs Through Inventory Control

How should the problem of controlling supply costs through inventory control be addressed? The author will outline what was done by the Chesapeake and Ohio Railway, how it was done and some of the continuing benefits which are being realized by the company.

W. J. ECK, Gen. Mgr., Purch. & Stores Dept., The Chesapeake & Ohio Railway Co., Cleveland, Ohio

Saving Money Through Modern Purchasing and Inventory Control

A change in inventory and purchasing procedures at Truax-Traer has resulted in labor savings as well as reduced the amount of capital tied up in spare parts. Here is how the job was done.

R. A. DODDS. Dir. of Pur., Truax-Traer Coal Co., Chicago, Ill.

Employee Testing

Can the performance of potential continuous mining machine operators be predicted through the use of simple aptitude tests? The answer is being sought through the evaluation by a task group of the AMC Coal Division Committee on Mechanical Mining of results from tests given to continuous mining machine operators and compared with their performance.

Rep. of AMC Committee on Mechanical Mining

(continued)

9:00 A.M. STRIP MINING

Chairman: ARNOLD E. LAMM, Pres., Pittsburg & Midway Coal Mining Co., Pittsburg, Kan.

Vice Chairman: H. M. TIBBS, Vice Pres.—Opers.—Coal, Truax-Traer Coal Co., Chicago, Ill.

Inclined Drilling and Blasting

Blast holes drilled parallel to the highwall face offer several advantages over vertical blast holes. The author will discuss experiments with blast holes drilled from 10 to 40 from the vertical, including the effect on drilling procedures and blasting costs.

B. J. KOCHANOWSKY, Dept. of Mng., Pennsylvania State University, University Park, Pa.

Economics of Large vs. Small Haulage Units

Faced with the problem of whether or not to purchase larger coal haulage units to replace a fully depreciated fleet of smaller trucks, Central Ohio Coal Co. made several careful cost studies, the results of which are discussed by the author.

E. F. ECKHARDT, Mgr. of Coal Mng., American Electric Power Service Corp., New York, N. Y.

Combination Truck and Belt Haulage

In discussing combination belt and track haulage, the author will outline relative costs at Stonefort and discuss the advantages and disadvantages of the system which has been in operation for several years.

ROBERT S. HUMPHREYS, Chf. Engr., Stonefort Coal Mining Co., Indianapolis, Ind.

Interconnection of Hoist and Crowd Controls—A Step Toward Shovel Automation

As shovel and dragline sizes have changed, so have the electrical controls. The paper will analyze the difference in performance of various types of controls and discuss production aids such as television and optical studies. Equipment available to integrate crowd and hoist motions for more nearly automatic operation will also be covered.

A. M. VANCE, Mng. Industry Engr., Westinghouse Electric Corp., East Pittsburgh, Pa.

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2:00 P.M. HAULAGE AND POWER

Chairman: JOSEPH M. RICHARDS, Gen. Mgr. of Mines, Blue Diamond Coal Co., Knoxville, Tenn.

Vice Chairman: A. C. MUIR, Elec. Engr., The Berwind-White Coal Mining Co., Philadelphia, Pa.

Experience With Silicon Rectifiers

Island Creek has been using silicon rectifiers for almost two years without an operating outage. The author will cover questions of voltage regulation and routine maintenance, as well as discuss operating experience.

JOHN A. DUNN, Chf. Elec. Engr., Island Creek Coal Co., Holden, W. Va.

Use of Brakeman Cars

The introduction of additional braking capacity has allowed Olga Coal Co. to handle more cars in a trip on mainline haulage without using an additional locomotive and its crew. Primary haulage is with a 40-ton tandem locomotive and the grade at places is in excess of 3 percent with the loads.

EMIL J. SERVANT, JR., Asst. Gen. Supt., Olga Coal Co., Coalwood, W. Va.

Application of Diesel Units Underground

Diesel haulage units have proven highly successful at T.C.I.'s iron ore mines where physical conditions are similar to those in most coal mines. The paper will cover operating and maintenance procedures and discuss haulageway ventilation.

Rep. of Tennessee Coal & Iron Div., U. S. Steel Corp.

Yieldable Mine Arches In Haulageways

Various mining methods and supports have been used by Bethlehem Mines to control difficult roof. The author will discuss experience with these systems and describe present methods and costs of reclaiming caved areas with yieldable steel arches.

GEORGE L. MAY, Div. Supt., Cambria Div., Bethlehem Mines Corp., Ebensburg, Pa.

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2:00 P.M. COST CUTTING IN OPEN PIT MINING

Program for Maintenance of Mobile Equipment

Production costs can be reduced by updating maintenance procedures. The speaker will discuss a newly developed maintenance program describing its major objectives, the results attained to date, and the ultimate gains expected.

HOWARD HANKS, JR., Operating Engr., Marquette Cement Manufacturing Co., Chicago

Maintenance at the Operation

Pointers on how to handle routine and emergency repairs and upkeep will be presented from the practical viewpoint of a cost-conscious operator.

JOHN G. WARNER, Plant Mgr., Chemstone Corp., Strasburg, Va.

Cutting Costs Through Operations Research

Increasing numbers of mineral producers are adopting an analytical approach to methods improvement. Inexpensive Operations Research programs have been highly successful in breaking production bottlenecks, and this talk will stress applications at the operational level.

JAMES L. COX, Mgr. of Minerals Operations, International Minerals and Chemical Corp., Bartow, Fla.

Blasting Vibrations in Quarry Operations

The mining industry is getting closer to the day of reckoning with the problem of blast vibrations in populated areas. This speaker will touch on shock wave theory, as developed at stone quarries where alleged vibration damage has already become a major consideration, and will discuss in detail some of the corrective changes in blasting practice at his company's operation.

DANIEL J. MILLER, JR., Chief Engr., Houdaille Construction Materials, Inc., Morristown, N. J.

Control of Large Blasts to Tonnage Requirements

A full year's supply of stone is broken in a single blast at Warner Company's Union Furnace Quarry using Ammonium Nitrate as well as conventional blasting agents. Shooting a 200-ft. face with 30 to 40 tons of explosives requires careful planning of burdens and spacing and well developed hole-loading techniques—all of which will be described.

H. A. CORRE, Plant Mgr., Bellefonte Operations, Warner Co., Bellefonte, Pa.

Wednesday, May 17

2:00 P.M. COAL PREPARATION

Chairman: C. K. TIECHE, Vice Pres., Clinchfield Coal Co., Dante, Va.

Vice Chairman: WM. CRENTZ, Asst. to Chief, Division of Bituminous Coal, U. S. Bureau of Mines, Washington, D. C.

Effect of Continuous Mining Equipment on Cleaning Plant Performance

Test results will be used to show the effect of continuous mining equipment under varying conditions on the size and specific gravity fractions of run-of-mine coal as compared to mining with conventional equipment. The effect on costs, caused by increased slack, raw coal moisture and extreme fines, will be brought out.

W. H. NOONE, Supt. of Prep., Semet-Solvay Div., Allied Chemical Corp., Montgomery, W. Va.

Heavy Medium Cyclones

The first dense medium cyclone plant in the U. S. was installed by Bethlehem Mines to clean 75 tons per hour of raw 3/8-in. by 28-mesh coal at specific gravities down to 1.35. The washing and magnetite recovery circuits will be described and washing results given.

WILLIAM BENZON, Supt. of Prep., Bethlehem Mines Corp., Johnstown, Pa.

An Electric Utility Looks At Its Future Use of Coal

The author will discuss trends in the use of various coal sizes by the electric utilities and describe C.E.I.'s experience in handling and burning pipeline coal. Certain practices will also be suggested to aid in the marketing of fine coal.

ROGER D. CURFMAN, Fuel Agent, Cleveland Electric Illuminating Co., Cleveland, Ohio

Recent Progress in the Thermal Drying of Fine Coal

Fine coal drying is becoming increasingly important as production from continuous mining machines increases and air pollution legislation becomes more restrictive. The author will describe various methods currently being used to dry minus 28-mesh material, and will suggest alternate solutions to the problem.

R. E. ZIMMERMAN, Vice Pres., The Paul Weir Co., Chicago, Ill.

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2:00 P.M. SAFETY

Chairman: WOODS G. TALMAN, Asst. Vice Pres.—Opers.—Coal, U. S. Steel Corp., Pittsburgh, Pa.

Vice Chairman: GEORGE TREVORROW, Safety Dir., Bituminous Coal Operators' Association, Washington, D. C.

Human Engineering in Safety

The knowledge of human behavior can pay off in increased safety. While human engineering is not an exact science, it is possible to apply it to improving conditions and in selecting people with the proper aptitude and abilities to do a safer job, and do it more efficiently.

C. G. EVANS, Pers. Mgr., The North American Coal Corp., Cleveland, Ohio

Benefits of a Sound Safety Program

In 16 years Armco has reduced its accident frequency rate from 98.8 to 3.87. The author will discuss the relationship between line and staff personnel in achieving this goal, as well as other techniques which have been found effective in the company's safety program.

C. O. KANE, Mgr.—Coal Mines, Armco Steel Corp., Montcoal, W. Va.

Evaluation of Various Means of Fighting Machine Fires Underground

Underground coal mine fires, if not extinguished quickly, can develop rapidly, create serious hazards and cause loss of life and property. The effectiveness of various extinguishing agents and techniques, and the problems and procedures for fighting a typical mining machine fire have been evaluated by the U. S. Bureau of Mines at its experimental coal mine.

DONALD MITCHELL, Chief, Experimental Coal Mine;

JOHN NAGY, Chief, Branch of Dust Explosions; and

EDWIN M. MURPHY, Chem. Engr., Experimental Coal Mine, U. S. Bureau of Mines, Bruceton, Pa.

Design of Pillars for Overburden Support

During the past 20 years much scientific and engineering data and a number of basic principles have been developed to greatly improve pillar design techniques. They concern probable pillar load, stress distribution, strength of coal in pillars, and bearing strength of roof and floor rock. These factors will be discussed as they relate to coal mine pillar design.

CHARLES T. HOLLAND, Head, Mng. Dept., Virginia Polytechnic Institute, Blacksburg, Va.

Discussion:

ROY L. DULANEY, Dir. of Safety, Mountaineer Coal Co., Fairmont, W. Va.

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2:00 P.M. STRIP MINING

Chairman: G. H. UTTERBACK, Sec.-Treas., United Electric Coal Cos., Chicago, Ill.

Vice Chairman: M. R. HECKARD, Supt., Rapatee Mine, Midland Electric Coal Corp., Farmington, Ill.

Application and Performance of Wheel Excavators

Wheel excavators are attracting wider interest in strip mining circles. The author will describe how and where the various type of wheels can be applied and what results can be expected.

HENRY RUMFELT, Appl. Engr., Bucyrus-Erie Co., So. Milwaukee, Wis.

Auger Mining Standards and Comparative Costs

Many variables determine the profitability of auger mining. The author will discuss the relative importance of these factors and develop production standards.

LOUIS F. ZAGER, Management Engr., Helmick & Associates, Cleveland, Ohio

Horizontal Air Drilling

The question of horizontal vs. vertical blast hole drilling has been revived by the development of horizontal rotary air drills. A large coal stripping company has found it advantageous to use the new drills under certain conditions.

N. O. LEWIS, Chf. Engr., Robbins Machine & Manufacturing Co., Inc., Oneonta, Ala.

Increasing Equipment Availability Through Maintenance

A good maintenance program pays off in machine availability. Here is how Hanna assures that its mining and haulage equipment is on the job full time.

THOMAS P. BRADFORD, Lub. Engr., Hanna Coal Co., Cadiz, Ohio

(continued)

9:00 A.M. COAL PREPARATION

Chairman: R. K. BOGERT, JR., Pres., Badger Coal Co., Philippi, W. Va.

Vice Chairman: R. L. LLEWELLYN, Prep. Engr., Eastern Gas and Fuel Associates, Pittsburgh, Pa.

Planning for Efficient Cleaning Plant Operation

The engineering that went into the selection of equipment for U. S. Steel Corp.'s Maple Creek preparation plant will be discussed. The plant is among the most modern and efficient in this country.

JAMES B. GIROD, Asst. Gen. Supt., Maple Creek Division, Frick District, U. S. Steel Corp., Uniontown, Pa.

Latest Developments for Continuous Analysis

The most obvious method of improving control and increasing efficiency in preparation plants is by continuous analysis. Some instruments to do this job are now on the market and others are in the research or development stage.

LOY A. UPDEGRAFF, Proj. Engr., Bituminous Coal Research, Inc., Columbus, Ohio

Substitutes for Standard Materials to Reduce Maintenance Costs

Many new materials are available that can increase the life of preparation plant equipment. The author will give a resumé of activity in this important area.

V. D. HANSON, Mech. Engr., Consolidation Coal Co., Library, Pa.

Processing and Disposal of Coal Flotation Tailings

The paper discusses the types of continuous thickeners and filters that are being employed in the coal industry, flow sheets, and the influence of plant beneficiation methods upon operating results. Special emphasis is placed on full scale examples to illustrate reasons for specific equipment selection, and operation for minimum cost and maximum simplicity.

DONALD A. DAHLSTROM, Vice Pres. and Dir., The Eimco Corp., Research and Development Center, Palatine, Ill.

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9:00 A.M. NEW OPERATIONS

Chairman: CECIL ARNOLD, Vice Pres. of Engr., Peabody Coal Co., St. Louis, Mo.

Vice Chairman: HARRY LAVIERS, JR., Exec. Vice Pres., South-East Coal Co., Inc., Irvine, Ky.

Each speaker will not only describe his mine but will also tell "why it's being done that way." The economics behind the opening of each property, the amount of exploration and pre-engineering, as well as the reasons for the choice of equipment and facilities will be discussed. Three of the properties are deep mines and one is a strip mine.

Orient No. 5

THOMAS L. GARWOOD, Chf. Engr., Freeman Coal Mining Corp., West Frankfort, Ill.

Thunderbird

W. A. ENDICOTT, Gen. Supt., Ayrshire Collieries Corp., Indianapolis, Ind.

SEGCO No. 1

J. E. BROWN, JR., Mgr. of Coal Opers., Southern Electric Generating Co.,
and
G. C. DYAR, Vice Pres.—Coal Mng. Opers., Alabama By-Products Corp., Birmingham, Ala.

Sunnyhill No. 9

JOHN H. PLUMP, Mine Supt., Sunnyhill Mine No. 9, Peabody Coal Co., New Lexington, Ohio

●

2:00 P.M. CONTINUOUS MINING

Chairman: N. T. CAMICIA, Vice Pres.—Opers., Island Creek Coal Co., Holden, W. Va.

Vice Chairman: J. ALLAN BROOKES, Mgr., Mather Collieries, Pickands Mather & Co., Mather, Pa.

Continuous Mining in Thin Seams (Two Papers)

The experience of two coal producers with continuous mining equipment in thin seams will be discussed. One author will describe the operation and performance of the Compton CU-42 miner. The other will describe the Lee-Norse LCM-28.

NORMAN YARBOROUGH, Gen. Mgr., Harlan Fuel Co., Yancey, Ky.

J. L. MARSHALL, Supt., Keystone Mine, Imperial Coal Co., Clymer, Pa.

Maintenance of Continuous Mining Equipment

The author will discuss maintenance of both ripper and boring type continuous mining machines, including a description of all changes that have been made in the machines by the coal producer, and what effect these changes have had on performance.

ARTHUR TOWLES, Maint. Engr., Bell & Zoller Coal Co., Johnston City, Ill.

Face Ventilation and Dust Control

Face ventilation with boring type continuous mining machines poses several problems because the machine so completely fills the face area. Here is the approach one company has taken to assure adequate ventilation in gassy seams.

JOHN S. TODHUNTER, Gen. Mgr., Barnes & Tucker Co., Barnesboro, Pa.

Make Your Plans Now To Attend!

All hotel and motel reservations are being handled through the Cleveland Hotel Reservation Bureau, 511 Terminal Tower, Cleveland, Ohio (Telephone: Main 1-4110). Advance registration already indicates that Cleveland's hotel accommodations will be taxed to the limit, so requests for reservations should be sent to the Bureau just as soon as possible.

Performance of Large Stripping Equipment

A report of AMC Committee on Strip Mining

By R. L. Geissel, R. A. Campbell, W. W. Dukes and G. H. Utterback

THERE have been many changes and improvements in stripping procedures in recent years. One of these, of course, has been the trend to larger shovels and draglines to meet ever rising costs. Development of large shovels has progressed to the point where 60–80 yd machines are now available, and 35-yd draglines are not unusual.

Early in 1960 the AMC Committee on Strip Mining decided that a survey of the performance of large shovels and draglines operating in the Nation's strip mines would provide a valuable reference to the coal mining industry. A subcommittee was set up and a questionnaire composed to gather the desired information. Purpose of this report is to summarize the results of the survey, which turned up some interesting information.

First, it should be pointed out that information was requested only on equipment having a capacity of 12 cu yd or over; and that engineering reports for the year 1959 be used. The following data was asked for: Bucket or dipper capacity; boom length; cubic yards of overburden handled per hour, per month and per year; the percent of running time; average and maximum overburden depth; quality of shooting; type of overburden, and whether the machine was working alone or in tandem.

In all, this information was received on 60 shovels and 29 draglines representing a total capacity of some 2643 cu yd.

It should be emphasized that no attempt was made to determine if individual machines were being properly applied. Also, the Committee's sampling is limited in some of the particular machine sizes, and a larger cross section—if one could be made—might alter the picture considerably.

There is another point that should be mentioned. The Committee, fully realizing that shovels and draglines each have their particular application, has not made any comparison of performance between the two types of machines and does not believe that this should be done unless all the variables affecting performance are considered.

Using the old rule of thumb for a measure of efficiency—cubic yards of material handled per cubic yard of bucket of dipper capacity—the collected data show that the earth-moving efficiency of shovels, up to and including 70 cu yd, is essentially constant. Disregarding the single 35 cu yd machine reported on, the same can be said for draglines.

Capacity per Hour per Yard of Bucket or Dipper Capacity

Shovels: Dipper Capacity (Cu Yd)	Capacity /Hr/Yd	Draglines: Bucket Capacity (Cu Yd)	Capacity /Hr/Yd
10–15	38	10–15	39
16–20	42	16–20	—
21–25	39	21–25	40
26–30	42	26–30	44
31–35	43	35	33
36–40	37		
41–45	42		
55	42		
65	46		
70	44		
Average	42	Average	39

Boom Lengths. The walking dragline which was originally designed for levee construction on the lower Mississippi River, has gained wide acceptance in various segments of the coal stripping industry because of its long reach. Boom length, for shovels as well as draglines, has increased as bucket and dipper sizes have increased.

Boom Length

Shovels: Dipper Capacity (Cu Yd)	Length (Ft)	Draglines: Bucket Capacity (Cu Yd)	Length (Ft)
10–15	90	10–15	172
16–20	96	16–20	—
21–25	102	21–25	189
26–30	108	25–30	196
31–35	108	35	220
36–40	119		
41–45	117		
55	145		
60	158		
65	140		
Average	113	Average	184

Running Time. Most mine operators reported running time as the time the crews were on a machine and actually moving overburden. For some companies, however, running time included deadheading, lubrication and/or time down for mechanical delays. These cases are noted in the tables, but are disregarded in the averages given on the next page.

From a cursory study of the data, it can be seen that size does not have any adverse effect on the amount of time a machine is in operation.

One operator of large shovels commented that he felt it was feasible to maintain an average of 1,200,-000 cu yds per month with a 45-yd machine. He also felt that mechanical delay-time could be limited to

Percent Running Time

Shovels		Draglines	
Dipper Capacity (Cu Yd)	Percent	Bucket Capacity (Cu Yd)	Percent
10–15	75	10–15	81
16–20	76	16–20	—
21–25	78	21–25	82
26–30	80	26–30	83
31–35	77	35	85
36–40	77		
41–45	78		
55	78		
65	77		
70	—		
Average	77	Average	83

eight percent; electrical maintenance and power supply to two percent; and other miscellaneous delays, such as deadheading, to five percent. This would leave 85 percent for digging. Some of the shovels reported on are doing this.

Overburden Depth. There is not much variation in average and maximum overburden depths between small and large shovel operations according to the survey—the average for all shovels is 44 ft and the average maximum is 65 ft.

The variation is somewhat greater for draglines. The average is 54 ft while the average maximum is 72 ft.

Overburden Depth

Shovels			Draglines		
Dipper Capacity (Cu Yd)	Avg. (Ft)	Max. (Ft)	Bucket Capacity (Cu Yd)	Avg. (Ft)	Max. (Ft)
10–15	32	46	10–15	47	67
16–20	36	48	16–20	—	—
21–25	47	72	21–25	58	73
26–30	44	55	26–30	59	71
31–35	50	65	35	85	130
36–40	44	61			
41–45	47	82			
55	41	60			
65	55	80			
70	55	90			

Conclusion. Although a place was left to make note of poor shooting on the questionnaire, no one admitted to poor shooting. It is difficult to know how to conclude a statistical report such as this, but the authors decided to do it by describing the average shovel and dragline as determined from the collected data:

Average Machine

	Shovel	Dragline
Bucket or Dipper Capacity	35 cu yd	19 cu yd
Boom Length	113 ft	184 ft
Overburden Handled/Hr	1471 yd/hr	765 yd/hr
Running Time	77%	81%
Avg. Depth of Overburden	44 ft	54 ft
Max. Depth of Overburden	65 ft	72 ft

SURVEY OF DRAGLINE PERFORMANCE FOR 1959

Machine No.	Bucket Capacity (Cu Yd)	Boom Length (Ft)	Overburden Handled (Cu Yd) Per Hr.	Per Mo.	Per Yr.	Running Time (Percent)	Overburden Depth Ave.	Max.	Overburden Type Rock	Shale	Other	Quality of Shooting Good	Fair	No Shooting	Hours Machine Down Due to Market Conditions or Holidays	Machine Working Alone	In Tandem	Machine No.
1	12	160	550	350,000	3,750,000	85	50	65	x	x		x			—	x		1
2	12	165	371	155,344	1,864,124	80	73	100	x	x		x			—	x		2
3	12	175	529	258,542	3,102,500	76	48	54		x	x			x	985	x		3
4	12	175	444	222,524	2,670,289	75	47	60	x	x	x			x	738	x		4
5	12	175	304	128,000	1,540,000	75	51	79	x	x	x	x			—	x		5
6	12.5	160	475	300,568	3,606,816	94	55	80	x			x			362	x		6
7	12.5	165	619	336,008	4,032,100	94	32	90	x			x			362	x		7
8	12.5	170	486	259,008	2,978,601	83	44	65	x	x		x			543	x		8
9	13	165	599	388,453	4,467,219	89	41	70	x	x		x			8	x		9
10	13	175	256	146,212	1,681,445	79	—	—	x	x		x			125		x	10
11	13	180	431	204,684	2,456,210	82	32	44	x	x		x			—	x		11
12	13	—	350	—	1,753,302	64	(A)	(A)	x				x		485	x		12
13	13	—	801	444,610(B)	—	86	73	80	x	x		x			24		(C)	13
14	14	160	650	420,000	4,500,000	85	40	50	x	x		x			—	x		14
15	14	215	683	400,000	3,592,225	83	24	30		x	x			x	1,680	x		15
16	20	195	1,039	442,050	5,304,600	80	20	45	x	x	x	x			2,160	x		16
17	21	195	478	271,427	3,257,123	85	27	—		x		x			1,008		x	17
18	21	200	851	379,000	4,544,000	61*	42	56	x	x	x		x		1,968	x		18
19	23	200	946	432,000	5,199,800	62*	35	55	x	x	x	x			1,416	x		19
20	(D)	185	1,286	579,773	6,667,394	81	60	75	x	x			x		2,360	x		20
21	25	180	748	420,000	4,289,740	80	69	80		x	x			x	1,208	x		21
22	25	180	865	505,000	5,579,410	81	86	100		x	x			x	416	x		22
23	25	180	835	499,351	5,992,207	89	87	97		x				x	—	x		23
24	27	180	1,161	516,897	2,842,931(E)	83	35	42	x	x		x			—	x		24
25	30	200	763	440,000	4,836,950	80	86	100		x	x			x	368	x		25
26	30	200	770	338,061	4,056,731	86**	71	110	x	x		x			2,664		x	26
27	30	200	1,052	612,204	7,346,455	86	77	84		x				x	—	x		27
28	30	200	1,112	650,000	—	91	40	60		x		x			—	x		28
29	35	220	1,167	566,402	6,796,826	82	85	130	x			x			362	x		29

(A) *Handling a 12 to 15-ft parting.*
(B) *Operated one month in 1959.*
(C) *In tandem with bulldozers.*
(D) *Machine had a 23-yd bucket for eight months and a 27-yd bucket for four months in 1959.*
(E) *Operated 5½ months in 1959.*
* *Running time includes normal operating delays such as oiling and mechanical, electrical and maintenance repairs.*
** *Running time includes deadheading.*

SURVEY OF SHOVEL PERFORMANCE FOR 1959

Machine No.	Dipper Capacity (Cu Yd)	Boom Length (Ft)	Overburden Handled (Cu Yd) Per Hr.	Overburden Handled (Cu Yd) Per Mo.	Overburden Handled (Cu Yd) Per Yr.	Running Time (Percent)	Overburden Depth Ave.	Overburden Depth Max.	Overburden Type Rock	Overburden Type Shale	Overburden Type Other	Quality of Shooting Good	Quality of Shooting Fair	No Shooting	Hours Machine Down Due to Market Conditions or Holidays	Machine Working Alone	Machine Working In Tandem	Machine No.
1	10	85	400	75,000	—	75	45	65	x	x	x	x			—	x		1
2	13	85	409	200,000	1,770,553	70	22	25	x			x			1,784	x		2
3	15	87	434	240,000	2,639,536	83	29	35	x	x		x			1,062	x		3
4	15	90	762	311,966	3,743,591	68	33	55	x	x	x	x			1,488	x		4
5	15	94	632	370,000	2,444,566	78	20	35	x	x		x			3,171	x		5
6	15	—	426	206,798	—	67	22	28	x	x		x			None	x		6
7	15	96	610	273,043	3,276,514	85	50	80	x	x		x			—	x		7
8	16	95	723	312,970	3,755,640	79	21	39	x	x	x	x			1,944	(A)		8
9	17	95	655	276,000	3,308,850	58*	32	47	x	x	x		x		1,920	x		9
10	17	95	707	237,653	—	75	43	46	x	x		x			—	x		10
11	18	105	866	406,723	4,880,679	78	39	75	x			x			361	x		11
12	20	89	855	459,562	5,514,746	80	50	—	x				x		1,008		x	12
13	20	96	745	420,000	4,636,778	84	29	35	x	x		x			1,024	x		13
14	22	95	601	249,755	2,747,301	80**	52	70	x	x		x			3,061		x	14
15	22	110	978	495,765	5,949,185	74	52	70	x	x	x	x			512	x		15
16	24	100	1,102	566,019	6,792,233	79	37	75	x	x	x	x			—	x		16
17	26	95	996	523,311	6,279,740	76	46	60	x	x	x	x			504	x		17
18	26	115	1,058	625,000	6,879,408	81	35	50	x	x		x			360	x		18
19	28	123	1,451	890,000	9,801,887	80	49	55	x	x		x			25	x		19
20 (B)	29	—	1,405	709,145	—	81	54	60	x	x		x			120	x		20
21 (B)	29	—	1,394	886,189	—	86	62	70	x	x		x			8	x		21
22	30	102	1,174	700,000	8,020,466	83	24	30	x	x		x			309	x		22
23	30	105	1,362	675,000	8,127,500	68*	42	62	x	x	x	x			888	x		23
24	30	—	1,031	540,712	6,488,541	84	36	55	x	x	x		x		1,960	x	x	24
25	(C)	133	1,275	547,855	6,300,330	72	33	40	x				x		1,856	x		25
26	33	105	1,210	634,473	7,296,441	75	49	59		x	x			x	696	x		26
27	33	108	1,336	555,210	6,662,500	77	29	41	x	x	x	x			2,120	x		27
28	33	113	1,504	805,412	9,664,946	79	77	85	x	x		x			—		x	28
29 (B)	33	—	1,825	1,164,094	—	86	33	50	x	x	x	x			—	x		29
30	35	105	1,405	594,040	7,128,985	69	34	60	x	x	x	x			1,408	x		30
31	35	108	1,311	699,935	8,399,221	80	76	80	x	x	x	x			794		x	31
32	35	108	1,640	717,551	8,610,607	65	53	80	x	x	x			x	714		x	32
33	36	100	997	570,000	6,289,871	79	41	70	x	x		x			461		x	33
34	36	113	1,459	506,589	6,079,068	77	33	40	x	x		x			—	x		34
35	40	113	1,530	609,054	7,308,644	71	49	60	x	x		x			—		x	35
36	40	120	1,321	568,626	6,823,517	71	57	75	x	x	x	x			1,456	x		36
37	40	120	1,408	—	8,576,795	74	45	76	x	x	x	x			342	(D)		37
38	40	120	1,329	686,838	8,242,058	75	67	72	x	x	x	x			458		x	38
39	40	120	1,940	1,200,000	13,186,639	82	40	60	x	x		x			91	x		39
40	40	127	1,339	610,000	5,052,242	76	24	35	x	x		x			3,138	x		40
41	40	135	1,749	1,000,000	10,938,417	86	37	65		x		x			1,133	x		41
42	42	135	2,205	730,664	8,767,972	73	37	43	x	x		x			—	x		42
43	45	105	1,479	750,000	6,433,459	83	31	60	x	x			x		2,990	x		43
44	45	113	1,662	865,390	10,384,682	79****	46	82	x	x		x			760	x		44
45	45	120	1,795	817,067	9,804,801	77	39	110	x			x			361.5	x		45
46	45	120	1,765	798,985	9,587,814	76	56	105	x			x			361.5	x		46
47	45	105	2,263	1,310,859	15,730,310	87	44	90	x	x	x		x		—	x		47
48	45	113	1,540	722,587	6,503,285	81****	76	103	x	x		x			1,272***		x	48
49	45	120	1,916	786,548	9,438,570	75	34	63	x	x		x			—	x		49
50	45	120	1,928	1,050,809	12,609,709	81	44	90	x	x	x		x		—	x		50
51	45	120	1,966	869,116	10,429,396	69	57	90	x	x	x	x			—	x		51
52	45	120	1,972	1,103,441	13,247,295	84	59	90	x	x	x	x			—	x		52
53 (E)	45	—	1,820	850,000	—	68	40	60	x	x			x		40	x		53
54	55	145	2,321	1,300,000	13,550,169	78	41	60	x	x			x		888	x		54
55	65	—	2,768	1,200,000	12,182,347	71	41	60	x	x			x		59	x		55
56	65	150	2,958	1,592,473	19,109,678	80	80	120	x	x	x	x			—	x		56
57 (F)	65	165	3,165	1,900,000	—	81	44	60		x		x	x		—	x		57
58	70	140	2,879	1,600,000	14,662,648	—	60	100	x	x			x		297	x		58
59	70	140	3,135	1,600,000	20,918,728	78	66	104	x	x			x		29	x		59
60 (G)	70	140	3,200	1,531,755	13,380,279	58	38	65	x	x	x			x	1,020	x		60

(A) Machine worked alone 92 percent of the time in 1959; in tandem 8 percent of the time.
(B) Operated only one month in 1959.
(C) Operated seven months with a 32-yd dipper and five months with a 26-yd dipper in 1959.
(D) Shovel operated alone most of the time, however in deep material a dragline worked on the spoil.
(E) Operated three months in 1959.
(F) Operated 2½ months in 1959.
(G) Low operating time, which affected yardage, due to crews being used to replace redesigned parts. Operator reports data does not present true picture of machine capacity.
** Running time includes normal operating delay such as oiling, and mechanical electrical repairs.*
*** Running time includes deadheading.*
**** Shovel also parked three months during 1959.*
***** Running time includes regular oiling and deadheading.*

wheels of government

As Viewed by HENRY I. DWORSHAK of the American Mining Congress

NOW that the 87th Congress has completed its routine organizational work, including the naming of new members to Committees, it is beginning to move on various legislative facets of the Kennedy Administration's program.

The Senate has already begun to debate a bill which would establish a nearly $400 million program of Federal aid to help redevelop depressed areas, and the House Labor Committee has all but completed action on a bill which would raise the Federal minimum wage from the present $1 per hour to $1.25 over a period of 28 months.

Meanwhile, the Department of the Interior, focal point of any national minerals policy which the new Administration may develop, has concerned itself with imports of residual oil, a major competitor of coal in Eastern Seaboard markets, but has not yet issued any statements regarding policy toward the metal mining and industrial minerals industries.

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> ## Washington Highlights
>
> **WILDERNESS:** Mining witnesses oppose resources "lock up"
>
> **RESIDUAL OIL:** Import ceiling for quarter raised
>
> **LEAD-ZINC:** Subsidy bill supported at hearings
>
> **FUELS POLICY:** Study resolution on House calendar
>
> **WATER POLLUTION:** House committee sets hearings
>
> **MINE INSPECTION:** Bill would affect metal mines
>
> **STOCKPILE:** Large-scale disposals will be studied
>
> **DEPRESSED AREAS:** Aid bill before Senate
>
> ★ ★ ★ ★ ★ ★

MINING WITNESSES OPPOSE WILDERNESS LEGISLATION

Four spokesmen for the mining industry registered strong opposition, at Senate Interior Committee hearings February 27–28, to a bill which would set up a National Wilderness Preservation System. They opposed it on the basis that the System would include some 14 million acres of national forest lands now open to prospecting and mining under the general mining laws.

These forest lands would constitute the nucleus of the Wilderness System, in which the measure would virtually exclude mineral development. Located for the most part in generally remote mountainous areas of the West, the lands have been subjected to little mineral exploration by modern geophysical and geochemical methods. Regardless of their potential value to the Nation mineralwise, the bill would segregate these areas "for the use of enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness." The measure defines wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

Initial mining witness was W. Howard Gray, a Nevada attorney who appeared in behalf of the American Mining Congress. Gray, who is chairman of AMC's Public Lands Committee, pointed out that the closing of such large areas to mineral development would be in direct contrast to the U.S.S.R.'s goal of encouraging such development within her boundaries through a top-level government agency.

Gray also declared that the creation of single-use wilderness areas "is a wide departure from the multiple-use-of-public-lands concept heretofore favored by Congress" in recent public land laws. He emphasized that no withdrawal of public lands should be made for any single-purpose use without prior determination that such use is of higher value than all other land-resource use, and should be accomplished only by act of Congress.

On behalf of the Northwest Mining Association, Russell Chadwick, Spokane, Wash., exploration geologist, testified that the proposed Wilderness legislation "appears to us as a huge land grant which is in effect a subsidy for a certain few hobbies which only a few people enjoy." He contended that the lands involved "are unquestionably prospective for mineral deposits and for industrial raw materials," but have not been evaluated in any recognized manner. He added: "Geologic mapping in the high mountain areas is, of course, slow and expensive relative to many other easier areas which also need doing. On that account, the Government surveys, both State and Federal, as well as the private exploration groups, have very spotty coverage in these areas."

Chadwick also noted that, if prospecting is unsuccessful, no harm is done; if successful, the Nation gains new mineral wealth on which continued industrial growth can be firmly based.

James Keane, Wallace, Idaho, attorney who represented the Idaho Mining Association, suggested that the Committee delay its consideration of the bill until it receives next January the report of an Outdoor Recreation Resources Review Commission now making a study of the Nation's future recreation needs. He pointed out that enactment of the legislation

"would be detrimental to mining and would damage the future economy of the State of Idaho."

Warren S. Moore, managing director, Fremont Mining Co., also expressed opposition to the bill, particularly with respect to its potential effect on mining development in Alaska.

UDALL HIKES CEILING ON RESIDUAL OIL IMPORTS

Secretary of the Interior Stewart L. Udall last month increased allowable imports of residual fuel oil during the first quarter of 1961 by 100,000 barrels daily, bringing the daily import level for the three-month period to 630,000 barrels daily. The Secretary said the increase was required "to assure that shortages of residual oil along the East Coast will not develop with subsequent hardships to users of this industrial and institutional heating fuel, particularly those whose choice of alternate fuels is limited."

Udall's announcement of the higher quota brought quick reaction from the coal industry, waging an unceasing battle to stem the tide of these imports which have been making inroads into traditional coal markets. The National Coal Association noted that, "because half the first quarter is passed, the actual imports permitted until April 1 will be about an extra 200,000 barrels a day, or a total increase of more than 9 million barrels for the first quarter." Deploring the increase, the National Coal Policy Conference said that a permanent increase of 100,000 barrels a day would wipe out the already depressed coal mining areas in West Virginia and Pennsylvania.

At an Interior Department hearing a few days later, coal industry spokesmen made a strong case for continuance of Government controls over imports of residual fuel oil, referring to unemployment in the coal industry and the sufferings of miners, losses to railroads, and general depression in coal-producing areas.

In addition, 18 Senators urged the President to approve a "substantial" reduction in the residual oil import quota to allow the coal industry to regain part of its market and encourage domestic oil producers to find new sources of supply. They warned the President that increasing oil imports is an invitation to "economic disaster in the coal, domestic oil, and railroad industries."

Early this month Secretary Udall announced that, beginning April 1, the maximum importing level for the next 12 months has been set at 461,427 barrels daily. He said the provision of annual, rather than quarterly, allocations would increase the supplying industry's flexibility in meeting consumer requirements.

LEAD-ZINC SUBSIDY BILL IS SUBJECT OF HEARINGS

The House Interior Subcommittee on Mines and Mining held hearings March 9–10 on proposed legislation to authorize payment of Federal subsidies to small domestic miners of lead and zinc. The measure under consideration is identical to a bill passed last year by Congress but vetoed by President Eisenhower.

Observers had anticipated that Interior Secretary Udall, or another spokesman for the Interior Department, would give the Subcommittee the Administration's views on this legislation, but the Department did not have its comments ready.

The legislation would authorize payment of Federal subsidies to domestic mine operators producing not more than 2,000 tons of lead and 2,000 tons of zinc from not more than one mine in each State or mining district. The subsidy payments would be at a rate to give producers the equivalent between what they actually receive at current prices and what they would have received at market prices of 17 cents per pound for lead and 14½ cents per pound for zinc.

Clark L. Wilson, chairman of the Emergency Lead-Zinc Committee, testified that producers eligible for benefits under the proposed legislation are in need of immediate help, but suggested that other segments of the domestic lead-zinc mining industry also should be considered. He pointed out that western States in particular have independent miners who are in trouble but can not qualify for assistance under the proposed legislation.

Wilson said that the basic problem confronting the lead-zinc industry is excessive imports. "We have been willing to try any practical method of import control that would provide long-term stability to the domestic mining industry whether the mine involved is independently owned or is a part of an integrated operation," he stated. "I'm sure you can all agree that in the light of present metal prices and metal stocks that an overall, long term lead-zinc minerals policy is needed now more than ever."

Tom Kiser, president, Tri-State Zinc & Lead Ore Producers Association, voiced "full-hearted support" for the legislation. But, he noted, "we do not regard it as a complete solution of domestic lead-zinc problems."

John Clark, president, International Union of Mine, Mill & Smelter Workers, told the Subcommittee that only "a handful" of the workers who have been working in the small domestic mines would qualify for assistance under the proposed legislation. "A subsidy program for all mines, with appropriate limits on the production to be subsidized, we believe, would have a more significant effect on total production and employment."

Congressional authors of the legislation, in addition to Subcommittee Chairman Edmondson (Dem., Okla.), who spoke in support of it were Reps. Pfost (Dem., Idaho), Baring (Dem., Nev.), Morris (Dem., N.M.), Montoya (Dem., N.M.), Thomson (Rep., Wis.) and McVey (Rep., Kan.).

FUELS STUDY RESOLUTIONS PROGRESS IN CONGRESS

Now pending on the House calendar is a resolution by Rep. Aspinall (Dem., Colo.) which would create a special 15-member House Committee to conduct a National fuels study. The Resolution was approved February 23 by the House Rules Committee, in preference to earlier resolutions calling for a joint Senate-House committee to make such a study.

The resolution would direct the special committee to make a thorough study of the current and prospective fuel and energy resources of the Nation, their present and probable future rates of consumption, Government policies and laws affecting fuels and energy industries, and the need, if any, for legislation to provide an effective national fuels policy.

On the Senate side, 63 Senators have cosponsored a resolution which would authorize a special 9-member Senate Committee to conduct a similar study. This resolution has been referred to the Senate Committee on Rules and Administration.

HEARINGS ARE SCHEDULED ON WATER POLLUTION BILL

Moving fast to implement a recommendation of the President, the House Public Works Committee announced it would hold public hearings March 14–21 on a bill by Rep. Blatnik (Dem., Minn.) to expand the Federal Government's role in the field of water pollution control.

This measure would set up a new agency in the Department of Health, Education and Welfare to administer the Federal Water Pollution Control

Act, authorize larger Federal grants to help pay for municipal waste treatment facilities, and strengthen Federal enforcement authority.

A major feature of the Blatnik bill would make the Federal control law applicable to all navigable and coastal waters, whether or not the pollution in any particular case affects only one State, if abatement action is requested by the State concerned. Under present law, a showing of interstate pollution is necessary before the Federal Government can step in.

The proposed legislation would also empower the Secretary of H-E-W to issue orders requiring abatement of pollution, rather than by filing suit to secure abatement as provided under present law. U. S. district courts would be empowered to enforce the Secretary's orders. The bill would also provide, however, that orders of the Secretary could be appealed to Federal courts.

METAL MINE INSPECTION BILL IS AGAIN INTRODUCED

Several Senators and Representatives have sponsored legislation which would authorize the U.S. Bureau of Mines to inspect all types of mines and mining operations other than coal or lignite mines, which are already covered by the Federal Coal Mine Safety Act. The purpose of the inspections would be to obtain information on health and safety conditions and causes of accidents or occupational diseases as a possible base for legislative recommendations to Congress. The bills are similar to those introduced in past Congresses.

The measures would also provide for creation of an advisory committee composed of three representatives of mine owners and three representatives of mine workers who, in cooperation with the Bureau, would "promulgate a code of reasonable standards and rules pertaining to safety and health conditions and practices in metallic and nonmetallic mines" to serve as a guide for making legislative recommendations.

The American Mining Congress has consistently opposed legislation in this field, on the basis that (1) the mining industry itself is best qualified to meet and overcome its own safety problems and has been making steady and impressive progress, and (2) State mine safety agencies can best serve local conditions and situations.

COMMITTEE WILL STUDY STOCKPILE DISPOSALS

Senator Robertson (Dem., Va.), Chairman of the Joint Congressional Committee on Defense Production, has announced that the Committee will study the feasibility of selling \$4 to \$5 billion worth of strategic and critical minerals and materials in the national and supplemental stockpiles. Robertson said he hopes to see approximately half of the stockpiles disposed of, if this action can be taken without disrupting domestic prices.

He explained that the materials were stockpiled to help the country prepare to fight a conventional war that might last three years or longer. In the present missile age, he said, much of the stockpile

(Continued on p. 89)

personals

John M. Kelly of Roswell, N. M., has been appointed Assistant Secretary of the Interior for Mineral Resources. A mining and petroleum engineer by profession, he will be responsible for activities of the Bureau of Mines, Geological Survey, and Oil Import Administration, as well as the Offices of Mineral Exploration, Minerals Mobilization, Coal Research, Oil and Gas, and Geography.

From 1937 to 1941 Kelly was active in the field of petroleum conservation and served briefly as a mining chemist for the American Metal Co. From 1941 to 1945, he was State Geologist of New Mexico and also a member of that State's Oil Conservation Commission which he was instrumental in organizing. At the time of his appointment, Kelly was president of his own oil producing company in New Mexico.

S. Austin Caperton, Jr., has been named general manager of Slab Fork Coal Co. He succeeds the late A. J. Walker.

Elmer F. Bennett, former Under Secretary of the Department of the Interior, has become a special partner in the law firm of Ely, Duncan and Bennett, Washington, D. C. He had served in the Interior Department since 1953 and had earlier been legal assistant to the late Senator E. D. Millikin. From 1948 to 1951 he was a trial attorney for the Federal Trade Commission.

John C. Doyle was recently elected chairman of the board of Jack Waite Mining Co. Doyle is president of Canadian Javelin Ltd., which is the largest shareholder in Jack Waite through its wholly owned subsidiary Simone Iron Corp.

The mining and milling activities of Kerr-McGee Oil Industries have been consolidated into one department as a result of the company's recent acquisition of the total interest of Kermac Nuclear Fuels Corp. **George H. Cobb,** formerly vice president of exploration, has been appointed vice president of the minerals department which includes all minerals exploration, mining and milling. **Vernon L. Mattson,** formerly manager of minerals, is now manager of research and development. **Marion F. Bolton** continues as vice president and general manager of Kermac Nuclear Fuels, and **Clifford L. Wise** continues as manager of the Kerr-McGee mill and mine at Shiprock, N. M. **R. T. Zitting** has been appointed manager of all mineral exploration for Kerr-McGee. He had previously been manager of minerals exploration and land.

George E. Warren has been elected chairman of the board of Southwestern Portland Cement Co. and has been succeeded as president by **Felix S. McGinnis, Jr.,** formerly vice president and secretary.

Hugh W. Strickland and **Charles F. Fogarty** have been named senior vice presidents of Texas Gulf Sulphur Co. Both had previously been vice presidents. Strickland will have charge of all corporate activities including sulphur production in the Gulf Coast region. Fogarty will be responsible for the company's exploration activities and its $25,000,000 potash project in Utah.

William B. Franke, former Secretary of the Navy, has become a director of Penn-Dixie Cement Corp.

Joseph Zimmerman, editor-in-chief of the Daily Metals Reporter and the Waste Trade Journal for more than 40 years resigned recently from these posts to become a consultant to Miles Metal Corp., world-wide traders and dealers in nonferrous metals, ores and alloys with headquarters in New York. Zimmerman is known internationally as an authority on metal economics and as a market analyst.

Veteran AMC Employe Retires

Gladys V. Ludlow, office manager of the American Mining Congress, retired March 1 after more than 40 years of service. Miss Ludlow is widely known by mining men and ladies throughout the industry as a result of her contacts through the Washington office, and also through her handling of entertainment tickets and other business in connection with the Mining Congress' annual conventions over the past years. After a short vacation in Florida, Miss Ludlow will reside at her home at 4526-45th Street, N.W., Washington 16, D. C.

Francis C. Bennett, superintendent of the Frederick coal mine, Colorado Fuel and Iron Corp., is retiring after 58 years in coal mining with a record of never having missed a day's work because of illness or injury. Bennett began mining at the age of 16. He joined CF&I in 1910 and except for a brief period in 1924 has had continuous service with the company.

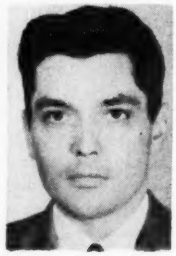
In 1925 Bennett was appointed superintendent of the Berwind, Tabasco and Toller mines. He later served as special sales representative and division sales manager for CF&I. From 1947 to 1954, he was successively named superintendent of the Crested Butte coal mine, the Morley mine and the Frederick mine.

Roy Ellerman, formerly with Stanleigh Uranium Mining Corp., Ltd., at Elliot Lake, Ontario, has been named project manager for the Gas Hills, Wyo., mining and milling operations of Federal-Gas Hills Partners. He succeeds **Raymond G. Lindlof** who earlier became project manager for the company's developments in the Shirley Basin. Ellerman was chief metallurgist, mill superintendent and mine manager for Stanleigh before joining Federal-Gas Hills.

Harold J. Spear was recently named to succeed **Walter Rothenhoefer,** vice president of Eastern Gas & Fuel Associates. Rothenhoefer is retiring but will continue as a consultant to the company.

Joins AMC Staff

Donald S. Whyte, former assistant to Secretary of the Interior Fred A. Seaton, has joined the public relations staff of the American Mining Congress. With the Interior Department since November 1959, Whyte served as a Congressional liaison officer and in public relations work.



Whyte came to Washington in 1954 with the FBI. During the following 4½ years, he served on the staff of Director J. Edgar Hoover and subsequently was managing editor of the FBI house organ, "The Investigator." He left the FBI early in 1959 to become a special assistant to Senator John Sherman Cooper of Kentucky. His service in the Executive and Legislative branches of the Government brought him into constant contact with many of the problems of the mining industry.

A native of Pierre, S. D., the new AMC staff member attended the University of Denver, American University, Washington, D. C., and Southeastern University, Washington, D. C.

William H. Klein, executive vice president of production, Dragon Cement Co. division of American Marietta Co., has retired. Klein joined Dragon in 1946 as operating manager and became vice president and a director in 1947. His cement industry career spans 55 years.

H. A. "Pat" Corre has been promoted to plant manager of the Bellefonte, Pa., operations of the Warner Co. He is in charge of the Bellefonte lime plant, Bell mine, and quarry at Union Furnace. He had been production superintendent, having joined Warner as superintendent of mining at the Bell mine in 1947.

John B. White, Jr., has joined Cerro Corp. as chief office engineer. He was formerly with Western Knapp Engineering Co. as chief engineer and earlier held a similar post with Susquehanna Western, Inc.

Ernest R. Rodriguez has been named chief, Spokane Office of Mining Research, U. S. Bureau of Mines. He was formerly mining health and safety engineer in the Bureau's accident prevention and health division at Denver. Rodriguez joined the Bureau in 1949 and has since worked principally in the field of ground support, especially rock bolting. For the last five years, he has given guidance to personnel assigned to roof control work in 11 western states.

Sidney C. Howell has joined Reserve Mining Co. as staff assistant to the manager, Babbitt division. He had been manager of the northern ore mines district of Republic Steel Corp. since 1958.

Other changes among Reserve personnel include naming **Matthew R. Banovetz** assistant superintendent in the pellitizing department at Silver Bay; **Raymond J. Bertie** assistant superintendent in the mining department at Babbitt, and **Joseph Pastika, Jr.,** staff mining engineer at Babbitt.

Otto L. Yauch, formerly manager-engineering and mine development for Pickands Mather & Co., has opened a consulting engineer office in Duluth, Minn. Yauch had been with Pickands Mather for 43 years and was manager of engineering and mine development from 1957 until his retirement last year.

Kenneth Wilson has resigned his position as exploration geologist with American Smelting and Refining Co. to open consulting offices in San Francisco at 400 Montgomery St., and in Menlo Park, Calif. Wilson, who was in charge of Asarco's West Coast Exploration office in San Francisco, had been an exploration geologist with the company for the past 17 years. He was the company's specialist in problems of ownership and acquisition of property for exploration.

Stanley E. Jerome was recently appointed associate director of the Nevada Bureau of Mines and the Nevada Mining Analytical Laboratory at the University of Nevada. Prior to his present appointment, Jerome was consulting geologist for Hunting Geophysical Services, Inc. Earlier he served for several years as district geologist of Bear Creek Mining Co. and as chief geologist of Gulf Minerals Co. From 1937–1954 he was with New Jersey Zinc Co.

Obituaries

Harry A. Treadwell, 75, retired vice president-operations for the Chicago, Wilmington and Franklin Coal Co., died enroute to the West Coast on the night of December 16 at Lincoln, Neb.

Mr. Treadwell, who was well known throughout the coal industry, began a 38-year career with CW&F in 1916 following several years of underground work with the U. S. Reclamation Service in the West. He joined the company in its engineering department and subsequently went into operations where he held various supervisory positions until becoming vice president of operations. He retired in 1954.

James M. Cook, 83, retired vice president and general superintendent of Imperial Coal Corp., died in Johnstown, Pa., on January 28.

Harry S. McClain, vice president of sales, Wellston Division, McNally Pittsburg Mfg. Corp., died in Wellston, W. Va., December 29, 1960.

Mr. McClain was well known in the West Virginia coal fields, where he had been associated with the sale of coal preparation equipment for some 40 years, first with Morrow Manufacturing Co. and then with McNally Pittsburg after it acquired Morrow.

Ernest F. Burchard, 80, retired mining geologist, died in Washington, D. C., on February 1, the victim of a fire. Mr. Burchard retired in 1945 after 41 years with the U. S. Geological Survey. During World War II he organized emergency efforts to expand the country's bauxite reserves.

NEWS and views

World's Largest Sinter Line Goes Into Operation

The largest single-strand sinter plant in the world has been put into operation by Jones & Laughlin Steel Corp. at Aliquippa, Pa. It is capable of producing more than 225,000 net tons per month of high quality feed for blast furnace.

Built by Dravo Corp., under a licensing agreement with Lurgi Co. of Germany, the J&L machine has a grate width of 13 ft 2 in. and is 183 ft 9 in. long over the 14 windboxes, for a total hearth area of 2419 sq ft. The plant has a design capacity of 8500 net tons per day of self-fluxing sinter.

In addition to having the widest and largest hearth, the J&L facility is equipped with the world's largest circular cooler, designed to bring the temperature of the sintered product down from about 1450° F surface temperature to a heat level at which the sinter can be handled by rubber belt conveyors without belt damage.

With the new installation at the Aliquippa Works, a recently-installed sinter plant at Cleveland, and improvements in sintering operations at the Pittsburgh Works and at J&L's New York Ore Division, the diet for blast furnaces at J&L's three steel plants will consist entirely of screened sinter and coarse iron ore.

Boone County Coal Corp. Sold

The principals of Logan & Kanawha Coal Co., Inc., have purchased the Boone County Coal Corp. mining properties at Sharples, W. Va. The new concern, which will be known as Utilities Coal Corp., proposes to operate Boone under the name of Boone County Coal Corp. Logan & Kanawha will market the coal under the Vesta Chilton trade name. Present plans contemplate this mine will load only deep mined Chilton seam coal. All sizes will be washed and centrifugally dried. Production is expected to be in excess of 1,000,000 tons annually.

Student-Trainee Program Commences at Penn State

Inauguration of a five-year work-study plan in mining engineering last year has resulted in a class of 25 freshmen alternating periods of attendance at Pennsylvania State University with on-the-job experience in the mining industry. The student-trainee program began last July in cooperation with 17 companies representing all segments of mining. Designed exclusively for mining engineering, it is one of the few such programs in existence in the United States.

Most companies have selected a pair of young men for whom a single job is provided. Student-trainees alternate six-month periods of work and study, one trainee of the pair being at Penn State while the other is on the job. They follow a rearranged curriculum towards a B.S. degree in mining engineering, completing it in five years instead of the usual four. In this time, however, they have obtained two years of practical experience while earning a college education.

Plans have already been laid for a second group of student-trainees to start September 25. The list of cooperating firms and agencies is being expanded, and interested companies are invited to contact Dr. Howard L. Hartman, head of the Department of Mining at Penn State.

New Iron Ore Pellet-Producing Operation Scheduled For Michigan

Cleveland-Cliffs Iron Co. recently announced the intention of Empire Mining Co., operated by Cliffs, to construct a high grade iron ore pellet-producing property mining low grade jasper ore, near Negaunee, Mich.

The Empire mine will be similar to the nearby Humboldt and Republic mines, also operated by Cliffs, in that low grade iron-bearing jasper rock containing about 30 percent iron will be mined by the open-pit method. The crude ore will be up-graded in a large crushing, grinding, and separation plant, producing a concentrate of over 65 percent iron. This fine concentrate will then be pelletized. The process will differ from other Cliffs low grade projects, however, in that the ore body at Empire is magnetic and will be separated from the waste rock by magnetic separators rather than by the flotation process utilized at Republic and Humboldt. This is the first magnetic low grade deposit to be developed in the Michigan mining region.

The project will have a capacity of over a million tons of pellets per year in the first stages of operation, and will be completed possibly by 1963.

Bituminous Coal Used As A Precise Scientific Standard

Cooperation between researchers at the U. S. Bureau of Mines Pittsburgh Coal Research Center and Varian Associates Inc., Palo Alto, Calif., has resulted in the selection of bituminous coal as a precise scientific standard.

Specifically, the researchers have discovered that vitrain—one of the major constituents of bituminous coal—from the Pittsburgh bituminous coal seam can be used as a basic comparison standard (in measurements with an electron paramagnetic resonance spectrometer) for determining the free-radical content of other substances. Free-radical is a term used to describe any chemical substance that has an unpaired electron.

Pittsburgh bituminous vitrain was selected as a standard because it is readily available, has a high free-radical concentration, and exhibits great stability.

Enos Coal Acquires Blackfoot Mine

Enos Coal Mining Co. has acquired the Blackfoot mine in Pike County, Ind., formerly owned and operated by Blackfoot Coal & Land Corp. The Blackfoot mine has a production capacity of 750,000 tons per year.

Also, Pickands Mather & Co. announced it has purchased Inter-State Coal Co., Inc., of Indianapolis, which has acted as exclusive sales agent for the Blackfoot mine. Inter-State, under its new ownership, will continue to sell the Blackfoot production.

In addition to the purchase of the Blackfoot mine, it was announced by Enos Coal and Pickands Mather, its exclusive sales agent, that they have entered into a long term contract with the Indianapolis Power & Light Co. under which the Enos mines will ship a minimum of 700,000 tons a year to the utility's generating stations in Indiana.

Davison Closes One Mine, Expands Another

The Davison Chemical Division of W. R. Grace & Co. has completed extensive modernization and expansion of phosphate rock mining facilities at its Bonny Lake mine, Ridgewood, Fla. This modernization followed closing of the Davison Pauway No. 4 mine near Lakeland, Fla., after nearly 40 years of operation.

Two draglines, flotation and other beneficiation equipment at Pauway No. 4 were transferred to Bonny Lake. At the same time, much new equipment was installed to increase capacity at Bonny Lake.

International Symposium on Agglomeration Set for April 12-14

The First International Symposium on Agglomeration will be held in the Sheraton Hotel, Philadelphia, Pa., April 12-14. The program will be sponsored by American Institute of Mining, Metallurgical, and Petroleum Engineers, and will follow the Blast Furnace, Coke Oven and Raw Materials Conference of the AIME Metallurgical Society in the same hotel, April 10-12. Over-all theme of the Symposium is agglomeration in all phases of sintering, pelletizing, nodulizing, briquetting, powder metallurgy and other aspects, as related to ferrous and nonferrous metallic and nonmetallic materials.

During the six technical sessions, more than 30 papers from 11 countries will be presented. The official language of the Symposium will be English, but German and French interpreters will be available at all functions and sessions.

For information write: W. B. Stephenson, General Chairman, International Symposium on Agglomeration, P. O. Box 635, Paoli, Pa.

Wabush Iron Announces $20 Million Program

Wabush Iron Co. Ltd. has announced that construction work to cost in excess of $20,000,000 in total will be started in Quebec and Newfoundland in 1961 in connection with the Wabush Lake iron ore project. Involved are facilities needed before and leading to the further development of large-scale mining, processing and housing installations for the production of high grade iron ore concentrates at the company's Wabush Lake property in Labrador. The installations are part of the long range planning for development of the property, and will enable Wabush to maintain the original schedule for bringing it into operation.

In the vicinity of Pointe Noire, Quebec, where the ore will be loaded for vessel shipment on the St. Lawrence River west of Sept Iles, a 25-mile railway will be built from the harbor site to Mile 8 on the Quebec, North Shore & Labrador Railway, dredging for an ore loading dock will be done and the dock built, rough grading of the service and ore storage area will be done at the dock site and the building of service facilities will be started. The cost of this work will be in excess of $15,000,000.

At Wabush Lake, housing and other preliminary structures to be needed when project construction is started at the property will be built at a cost of approximately $5,000,000. These include living quarters and other facilities for feeding and maintaining a total of 1200 men.

Wabush Iron is presently owned by the Steel Company of Canada, Ltd., the Youngstown Sheet & Tube Co., Interlake Iron Corp., Inland Steel Co., Pittsburgh Steel Co. and Pickands Mather & Co., which is also managing agent.

LIA-AZI Joint Annual Meetings to be Held May 1-3

The 33rd Annual Meeting of the Lead Industries Association will be held jointly with American Zinc Institute at the Drake Hotel, Chicago, May 1-3.

The first day, Monday, May 1, will be devoted to the activities of American Zinc Institute only. The morning of the second day, May 2, will be a joint meeting of LIA-AZI, while the afternoon will cover activities of the Lead Industries Association only. The morning of the third day, May 3, will be devoted to "New Frontiers for Lead" and will include papers and discussion on new lead products and new applications of older lead products.

Social activities will include a joint LIA-AZI luncheon on Tuesday, LIA's traditional evening reception and buffet on Tuesday and the LIA luncheon on Wednesday.

ALSO . . .

In its quarterly report to shareholders for the three months ending December 31, 1960, Joy Manufacturing Co. announced that the first "Pushbutton Miner" was delivered to Peabody Coal Co. and that field tests are now in progress.

Eagle-Picher Co. plans to reopen its Central mill north of Commerce, Okla., sometime in March. Although the plant is capable of treating 12,000 tpd of ore, company officials anticipate a milling rate of approximately 2000 tpd during early operation. Several small independent producers have been notified of the reopening plans and some have already started reconditioning their mines for operation.

Island Creek Coal Co. has announced its entry into a new field—a chemical charcoal process—and plans for construction of a $600,000 plant at Red Jacket mine No. 17 in Mingo County, W. Va. The finished chemical charcoal will be sold to Union Carbide Chemicals Co. May is the target date for the new plant's opening, which will use an estimated 300 tpd of coal.

A new process for the continuous production of commercial sheet metals and alloys is being developed at Stevens Institute of Technology by the college's powder metallurgy laboratory. The process is expected to make possible the production of sheet metals or alloys in a continuous operation, thus saving time, reducing production costs and increasing plant efficiency. In the process metals or alloys in the form of fine powders are suspended in a liquid. The "sheets" so produced are continously passed through controlled atmospheric furnaces where they are brought up to temperatures just below their melting point. Known as "sintering," this heating consolidates the sheets which are then passed through mechanical rolls. A subsequent heating brings the sheets to required density.

American Zinc Institute and American Hot Dip Galvanizers Association plan to launch a joint research and development campaign to expand the uses of hot dip galvanizing and have earmarked a substantial sum for the initial effort. Purpose of the cooperative campaign, to be inaugurated early this year, is to stimulate research and experiment by architects, engineers and technical experts in many fields where hot dip galvanizing is not being utilized to its fullest potential, as well as to encourage product improvements.

Jefferson Lake Sulphur Co. has ceased operations in the Vinton-Starks area of Calcasieu Parish, La. Exhaustion of commercial supplies of sulphur was given as the reason.

New York Mining & Mfg. Company's $3,000,000 custom-coke plant at Little Cypress, Ky., has gone into production. It opened with 200 ovens and a production capacity of approximately 200,000 tons of coke per year, but ultimately it may be expanded to 500 ovens. Between 300,000 and 350,000 tons of coal will be used annually by the plant. Water transportation will be utilized for hauling material to the operation and transporting coke to Midwestern and Eastern markets.

The Pea Ridge development of Meramec Mining Co. is continuing with full production scheduled for May 1963. Located in Missouri, the iron mine is being designed to produce 12,500 tpd on a two-shift basis. Meramec is equally owned by St. Joseph Lead Co. and Bethlehem Steel Corp.

American Zinc Institute has moved its Detroit headquarters to new and expanded facilities at 638 New Center Building, Detroit 2, Mich.

THE REPORT CORNER

Recent Publications of Interest to Mining Men

"Thirtieth Annual Addition to the Flotation Index—for the Year 1959," prepared by the staffs of the Chemical Library and Technical Service and Development. The Dow Chemical Co., Midland, Mich.

Bulletin 17, "Progress Report on Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana—2. Southwestern Lincoln County," by Willis M. Johns. Free on application to the Montana Bureau of Mines & Geology, Room 203-B, Main Hall, Montana School of Mines, Butte Mont.

USGS Professional Paper 400-B, "Geological Survey Research 1960—Synopsis of Geologic search 1960—Short Papers in the Geological Sciences." Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $4.25.

USBM Information Circular IC 7988. "Tentative Safety Recommendations for Field-Mixed Ammonium Nitrate Blasting Agents," by Staff, Bureau of Mines.

Note: U.S.B.M. Information Circulars and Reports of Investigations can be obtained from the Publications—Distribution Section, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa. They should be requested by number and title.

USBM Information Circular IC 7978, "Mechanical Mining in Some Bituminous Coal Mines—Progress Report 9: Face Haulage," by J. J. Shields and J. J. Dowd. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 55 cents.

"Vibrations from Blasting Rock," by L. Don Leet. 148 pp. Harvard University Press, 79 Garden St., Cambridge 3, Mass. Price $4.75.

USGS Professional Paper 365, "Apparent Resistivity of a Single Uniform Overburden," by Irwin Roman. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 70 cents.

USGS Professional Paper 343, "Geology and Ore Deposits of the Summitville District San Juan Mountains Colorado," by Thomas A. Steven and James C. Ratté. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $2.00.

ALSO . . .

Grand Isle Sulphur Mine, located in the Gulf of Mexico seven miles offshore of Grand Isle, has been nominated by American Society of Civil Engineers for the 1961 "Outstanding Civil Engineering Achievement of the Year" award. It is one of 11 nominations made throughout the country for this year's outstanding engineering achievement. Judging will be by a jury of engineering magazine editors. The project is owned and operated by Freeport Sulphur Co.

Marquette Cement Mfg. Co. and Pittsburgh Coke & Chemical Co. have announced an agreement whereby Marquette will acquire all of the outstanding stock of Green Bag Cement Co., a wholly-owned subsidiary of Pittsburgh Coke. Marquette issued 150,000 common shares of Marquette to Pittsburgh Coke & Chemical, which will retain the Marquette stock as an investment.

Cleveland-Cliffs Iron Co. has suspended operations at its Mather "A" mine in Ishpeming, Mich., which reaches a depth of 3500 ft; it is said to be the world's deepest iron mine. The company is also decreasing the working force at the Cliffs shaft mine at Ishpeming and at the Mather "B" mine near Negaunee.

Standard Beryllium Corp. has purchased the Boa Vista concession in Brazil and is now the sole owner and operator. The concession was purchased from Icombra, S.A., and consists of over 1700 acres approximately 200 miles north of Rio de Janeiro. Standard Beryllium plans to extract beryl and other minerals through the use of an automated mill, which has been ordered and will be installed in the near future. At least one more, and possibly two more mills, will be put into operation before the end of 1961. One mill will process approximately 100,000 tons of crude ore per year.

The Philadelphia & Reading Corp. recently sold its coal mining operations to John B. Rich of Pottsville, Pa., owner of Gilbertson Coal Co. The sale included coal lands, breakers, equipment, inventory and supplies.

Mountaineer Coal Co. closed its Monongah mine, Monongah, W. Va., March 1. Reserves at the mine, which was opened in 1890, have been worked out. This is the mine where 361 men died on December 6, 1907, in an explosion and fire, the worst mine disaster in the nation's history. The mine was then owned by Fairmont Coal Co.

Revolutionary advancement of electric home heating throughout the United States with corollary gains for the coal, electric, railroad and home building and building materials industries was predicted by all members of this panel of experts at the national electric home heating conference sponsored in Washington, D. C., by the National Coal Policy Conference, Inc. Seated: John D. Damon, Electrical World; Lowell R. Mast, Commercial Controls Corp.; J. H. K. Shannahan, American Electric Power Co. Standing: Moderator, C. E. Anderson, Virginia Electric & Power Co.; Martin L. Bartling, Jr., United States Gypsum Co.; Michael F. Widman, Jr., United Mine Workers of America; W. W. McClanahan, Jr., National Coal Policy Conference; Fred H. Sides, National Mineral Wool Insulation Association; and Arthur Sworn Goldman, House & Home Magazine. Joseph E. Moody, president, National Coal Policy Conference, and Dr. George Cline Smith of F. W. Dodge Corp. also addressed the conference.

Work on American Potash & Chemical Corporation's new $5,000,000 manganese metal plant at Aberdeen, Miss., has been started. The new facility, scheduled for completion in November, will be American Potash's first full commercial manganese metal operation, although the company has produced the material on a pilot plant scale.

Inland Steel Co. plans to close permanently its Morris iron ore mine at Ishpeming, Mich., by early summer. The mine, opened in 1909, is one of the oldest on the Marquette Range. Rising costs, unusually difficult mining conditions resulting from excess water and the increasing availability of high quality, specially prepared ores contributed to making this action necessary.

The Tennessee Valley Authority has awarded a $30,400,000 contract to General Electric Corp. to build two 800,000-kw steam-powered turbo-generators. They will be used in a power plant which the Federal agency plans to build in southeastern Kentucky or on one of the tributaries of the Tennessee River. The first unit is scheduled to go into operation September 1, 1964, and the other a year later.

Formal transfer of all properties and assets of North American Cement Corp. to Marquette Cement Manufacturing Co. took place January 31. The transaction involved delivery of 575,158 Marquette common shares in payment for the assets and business of North American Cement Corp., which is being dissolved.

George E. Evans, Jr., president of Evans Elkhorn Coal Co., Inc., recently announced that he and associates have acquired ownership of Black Star Coal Corp., Louisville, Ky. Officers elected are Evans, president; John E. Corder, executive vice president; Richard L. Cooper, vice president-sales; and Paul O. Weisser, secretary-treasurer. Cooper was vice president of M & O Coal Co., and Corder and Weisser have long been associated with Black Star.

Cerro de Pasco Corp. has changed its name to Cerro Corp. The new name was adopted in the belief that a more general name, rather than one of local origin, would more readily suggest the scope of the company's present business and the future expansion of its activities. The company, which was founded in 1902, was named for the site of its first copper mine at Cerro de Pasco (hill of Pasco) in the Peruvian Andes.

WHEELS OF GOVERNMENT

(Continued from p. 82)

might have no practical value for military purposes.

DEPRESSED AREAS BILL DEBATED BY SENATE

The Senate began debate March 9 on a bill to implement a key plank of the new Administration's program—a measure which would establish a $394 million program for redevelopment of depressed areas, including coal mining areas in West Virginia, Pennsylvania and elsewhere.

If approved by the Senate Banking and Currency Committee, the bill would establish three $100 million loan funds for (1) more plants and expansion in industrial areas, (2) industries in depressed rural areas, and (3) public facilities.

The House Banking and Currency Committee is still in the midst of hearings on similar legislation.

NEWS and views

Western

Propose Integrated Copper Facility

Marinduque Iron Mines Agents, Inc., a leading producer of copper concentrates and other minerals in the Philippine Islands, proposes to build a $23,000,000 integrated, 42½ tpd copper facility in that island republic. The company plans to use a chemical reduction process for extracting copper metal from concentrates as opposed to conventional smelting and refining techniques. A similar chemical process is being used for producing nickel from nickel concentrates at Sherritt Gordon Mines Ltd. in Alberta. Copper produced would be in the form of a powder which would subsequently be processed into strip, wire, or tubing by means of a newly developed powder rolling technique. Among the stated advantages of the chemical reduction and powder rolling processes are that capital costs are greatly reduced, complex ores can more effectively be handled than with conventional methods, and small tonnages can be economically produced. A $13,000,000 loan for construction of the proposed plant has been approved by the Export-Import Bank and various U. S. interests are expected to participate in getting the project into production.

Arizona Steel Plant Being Put Up

A direct reduction plant for processing iron bearing black sands is being erected on an 80-acre site near Coolidge, Ariz., by Arkota Steel Co. The company plans to produce a 50 percent magnetic iron concentrate from black sands containing 5 to 15 percent recoverable iron. Concentrates will be further upgraded and then subjected to a reduction process which will result in a sponge iron containing about 95 percent iron. An electric furnace will process the sponge iron and iron ingots will be produced at a rate of about 75 tpd. The process, developed by J. D. Madaras, is being used in a 700 tpd plant in Mexico. Completion of construction at the Arizona site is expected in April. Arkota plans to sell the iron ingots on the West Coast where they will be further processed into marketable steel products.

Western Machinery Sold

Arthur G. McKee & Co., international engineering and construction firm for the steel, petroleum and chemical industries, has acquired Western Machinery Co. for $8,440,000.

The two companies announced last August that a preliminary agreement for the acquisition had been reached.

Western Machinery, which will operate as a wholly owned subsidiary of McKee, comprises three divisions —Western Knapp Engineering Division, WEMCO Division, and the Distribution Group. Western Knapp provides complete design, engineering and construction services for its customers in the fields of ore and materials. WEMCO manufactures mineral processing equipment for the mining, aggregate, coal and sanitation industry, while the Distribution Group is engaged in the sale and servicing of manufacturers products on a franchise basis to the construction, mining, manufacturing and utility industry.

Ore Discoveries at Sunnyside Mine

Standard Metals Corp. has intersected two potentially important ore deposits while completing its American tunnel project at the Sunnyside mine in the Silverton district, Colo. The intersections were made on two lead, zinc, copper, silver, and gold bearing veins below any previously known mineralization at the Sunnyside and are believed to be entirely new deposits. Standard Metals plans to develop the discoveries by drifting as it continues to extend the American tunnel to the downward projection of ore from the Sunnyside mine. The Sunnyside was abandoned after it flooded in the 1930's. At that time, remaining ore in the mine was estimated to be in excess of 400,000 tons.

ALSO . . .

Superior Mining & Dredging Co. has proposed to develop two Stevens County, Wash., lead mines, the Electric Point and Bechtol. Superior has leased the Electric Point from State Mining Co. with an option for purchase and intends to explore for new deposits of lead ore. The Bechtol, which is located on a three-claim tract, was purchased from State Mining. Superior is planning a new access road to the Bechtol and expects to install equipment for mining.

Webb & Knapp, Inc., has transferred its interests in a project to produce steel from copper smelter slag to Gulf States Land & Industries, Inc., a subsidiary. Webb and Knapp proposed erecting steel mills at Clarkdale, Ariz, and Anaconda, Mont., with construction at the latter expected to get under way this year. The steel making process involves direct reduction of slag with limestone and coal and use of electric furnaces.

Idaho Mining & Milling Co. plans to begin gold dredging operations in the Florence Basin of Idaho about July 1. The company has acquired placer rights on about 40 miles of stream beds in the region and has three dredges it plans to use for processing about 6500 cu yd of gold bearing gravels per day.

A 150 tpd phosphate processing mill has been placed in operation at Soda Springs, Idaho, by Valley Nitrogen Producers, a California fertilizer manufacturer. Mill treatment consists of grinding and drying. The company will contract its ore requirements from independent area producers on an annual basis.

Continued development of the Mikado and Little Squaw gold lodes in the Chandalar district, Alaska, by Little Squaw Mining Co., is anticipated. The company plans to continue underground development for the third straight season and will undertake surface trenching and road building during the coming season. In the 1960 season, a total of 655 ft of drifting and crosscutting was done at the Mikado alone, where results have thus far been promising.

Union Carbide Nuclear Co. has closed its Green River, Wyo., uranium ore upgrading mill. Henceforth the sampling, grinding and upgrading functions of the Green River mill will be undertaken at the company's Rifle and Uravan, Colo., mills. Decision to close the plant was reached following an economic evaluation.

Three companies, including Chief Consolidated Mining Co., Armet Co., and American Exploration and Mining Co., have formed a joint venture to develop the Holt silver mine near Enterprise, Utah. Over the past three years Chief Consolidated and Armet have been diamond drilling at the property and sufficient ore has been outlined to make mining feasible. Present work involves drilling a 24-in. hole for dewatering the site of a contemplated 600-ft shaft.

Daybreak Uranium, Inc. has acquired a 40-acre gold placer claim near Oatman, Ariz., which has been pooled with 15 other claims to make up the Silver Creek Grubstake group. The group is under development by Sierra Diamond Drilling Co. which plans an open pit mining operation.

A four-year contract between Mount Rainier Coal Co. and Mitsubishi Shoji Kaisha, Ltd., which represents eight Japanese steel mills, was recently signed. Under the contract Mount Rainier Coal will supply 800,000 tons of coking coal on a trial basis from the Wilkeson mine near Takoma, Wash. The Wilkeson mine has been idle except for brief periods since 1936. First shipments under the contract are expected next year.

Merger of Pacific Uranium Mines Co. into Kerr-McGee Oil Industries, Inc., has been anounced. Through the merger and with recent stock acquisitions, Kermac Nuclear Fuels Corp. has become wholly owned by Kerr-McGee. Kermac operates the Nation's largest uranium processing plant and holds some 20 percent of known U. S. uranium reserves. By the merger agreement, Kerr-McGee acquired Pacific's interest in certain uranium mining properties in the Ambrosia Lake, N. M., district, including 25 percent of the stock of Ambrosia Lake Uranium Corp. The latter company owns substantial reserves near the Kermac mill and is now 75 percent owned by Kerr-McGee.

Hecla Mining Co., long established lead-zinc-silver producer in the Coeur d' Alene district of Idaho, has established an exploration office in Tucson, Ariz. at 6101 East Oak St. The new office is under the direction of J. D. Bell, who has been an exploration geologist with Hecla for 11 years.

Production of pig iron has begun at the 100-tpd iron and steel plant of Consolidated Mining & Smelting Co., Kimberly, B. C. The plant, not yet operating at full capacity, is the first phase of a project calling for expenditures in excess of $20,000,000 to establish western Canada's first integrated steel works. When fully operative, the completed facility is expected to produce about 300 tpd of pig iron, steel ingots, and basic steel products. The plant processes tailings resulting from concentration of lead and zinc ores at Cominco's Sullivan mine in Kimberley.

The Conjecture mine shaft of Federal Resources Corp. in north Idaho will be sunk from the 1000-ft to the 2000-ft level this spring. The company also expects to drift through the mine ore zone to probe deep into the St. Regis formation.

Plans for a new sintering plant at the Kellogg, Idaho, lead smelter of the Bunker Hill Co. are in the making. The new system, which will simplify charge preparation and feeding of materials into the lead blast furnace, will eventually replace the present roasting system. The work will include erection of new storage facilities and materials handling equipment as well as installation of a new sintering machine and a fully automatic monorail charge car system that will dump feed directly into the blast furnace, as opposed to the present trolley charge car system.

A joint development project on properties controlled by Day Mines, Inc., and Knob Hill Mines at Republic, Wash., has revealed a new ore shoot northeast from all previous workings. Several hundred tons of the ore have been milled by the company. Elsewhere, continuance of the Gold Dollar vein 350 ft down-dip from the present lowest mine level has been verified by deep diamond drilling.

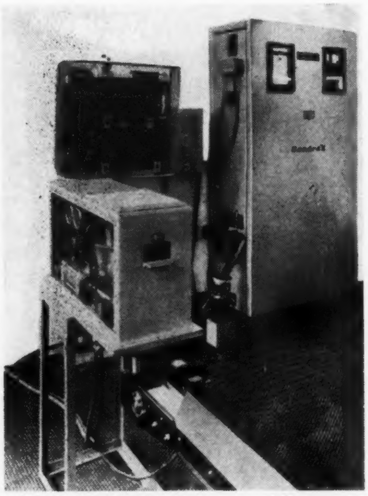
A gypsum deposit on Chichagof Island, Alaska, will be reappraised by the Bureau of Mines due to recent renewed interest shown in it. The Chichagof deposit is of high quality and believed to be of considerable size. Development of the deposit might now be economically feasible with the advent of improved mining methods and tax incentives offered to new industries in the State of Alaska.

Texas Gulf Sulphur Co. has made a contract with Stearns-Roger Manufacturing Co. for the design and erection of the concentrating plant for its $25–$30,000,000 Cane Creek, Utah, potash development. Initial capacity of the plant will permit processing about 8000 tpd of potash ore.

Columbia Iron Mining Co., a subsidiary of U. S. Steel Corp., has purchased a group of 62 iron mining claims in Pershing and Churchill counties, Nev. from Mineral Materials Co. and American Exploration & Mining Co. Also acquired in the transaction was Mineral Materials' magnetic ore processing plant at the Buena Vista mine property. The claims were purchased in looking to future needs of the Columbia-Geneva Division steelmaking operations in the western U. S.

Speaking before the New York Society of Security Analysts, on January 10, James M. Gerstley, president of United States Borax & Chemical Corp., said that potash appears to be in short or at least tight supply in world markets. He stated that there are indications of diminishing Western European potash reserves and until large scale production is established at major Canadian deposits, it is likely to remain in short supply. Hugo Reimer, executive vice president of U. S. Borax, disclosed that the company is currently studying the possibility of exploiting lower grade deposits at its operations in the Carlsbad district of New Mexico.

manufacturers forum

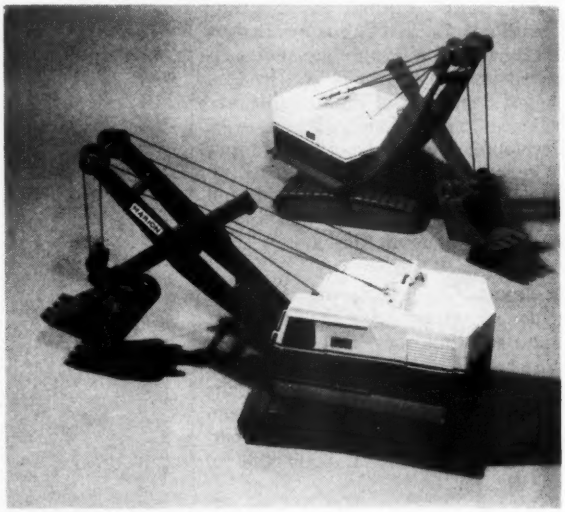


The Netherlands State Mines, in concert with N. V. Nederlandse Rontgenapparatenfabriek Evershed-Enraf of Delft, have successfully developed an apparatus to determine the ash content in raw coal.

Ash content is determined by exposing a prepared sample of coal to X-radiation and comparing the amount of reflection to a standard reference sample. The device can analyze a continuous sample and, thereby, become part of an automatic control. It is being handled in this country by American Minechem Co., P. O. Box 231, Coraopolis, Pa.

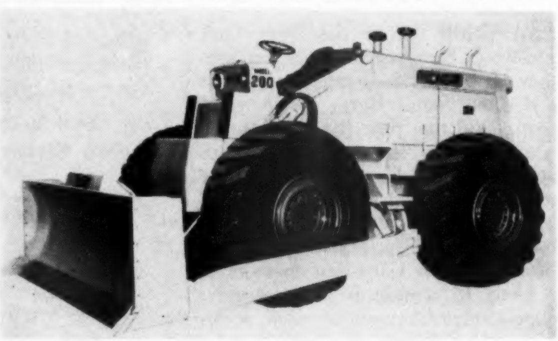
A LINE OF LIGHTWEIGHT TWO-WAY RADIOS for use in the mining industry has been engineered by Communication Products Dept., General Electric Co., Lynchburg, Va. They will be marketed immediately under the name General Electric Pacer. Designed for operation in low band (27-50 mc) and high band (150-174 mc), the units have full-quality VHF-FM audio and employ 15 tubes and 2 transistors. To eliminate vibrators, the control section contains a transistorized power supply adaptable to 12-volt negative or positive ground electrical systems. Using aluminum construction, the Pacer weighs only ten lb, including microphone and built-in speaker, and is 4¼ in. high, 7¾ in. wide and 12½ in. long.

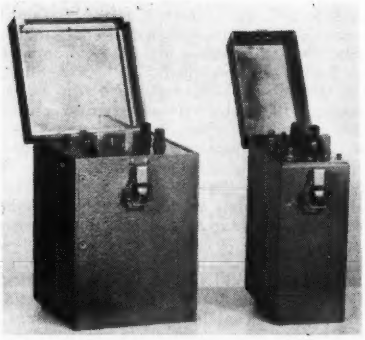
A MINIATURE SHOVEL can be built from model plans being offered by Marion Power Shovel Co., P. O. Box 505, Marion, Ohio. The plans, which are for a type 65-M shovel, consists of a 16 page book of instructions and 33 component and assembly drawings. Standard materials—principally ¼ in. plywood, white pine dimension stock, molding, and doweling—available at all lumber yards, go into the model, which can be built without any special tools. To date, the company has distributed over 500 sets of the plans. Requests for the model plans should be on Company Letterhead and addressed to Marion Miniatures at the above address.



A NONMETALLIC BACKING for managanese crusher parts involves an entirely new method of application, according to Nordberg Mfg. Co., Milwaukee, Wis. The new backing agency known as Nordbak can be poured at "room temperature" without the special pouring equipment or precautionary measures usually associated with metallic backing agents. It is claimed that no special preparation of the wearing part or its mating member is necessary and intimate initial support of the maganese is provided. Mixing and pouring of Nordbak is accomplished at the crushing site.

A 290-HP DIESEL ENGINE, from General Motors, is now available as optional equipment on the Michigan Model 280 Tractor Dozer, according to Construction Machinery Division, Clark Equipment Co., Pipestone Plant, Benton Harbor, Mich. The GM Model 8V-71 engine is designed to increase the dozer's flexibility and production and features a two-stroke engine cycle, unit injector fuel system and maximum parts interchangeability. The other power plant available for the machine is the 262-hp Cummins NTO diesel. Model 280 has a top speed of 28 mph in forward or reverse and employs a torque converter, four-speed power shift and all-wheel drive.





TWO NEW BLASTING MACHINES are now offered by Vibration Measurement Engineers, Inc., 725 Oakton St., Evanston, Ill. One, the VME-Sr., is a 450-volt rated blasting machine which weighs 15 lb and has a recommended capacity of 50 caps in straight series for primary blasts and 200 caps in straight series for secondary blasts. Fifty caps can be shot in straight parallel and 1200 in series parallel arrangements. VME-Jr. is rated at 225 volts and weighs eight lb. Its recommended capacity is 30 caps in straight series for primary blasts and 100 caps in straight series for secondary blasts. In series parallel 240 caps can be shot.

CATALOGS & BULLETINS

AUTOMATED PINCH VALVE SYSTEM. *Mine & Smelter Supply Co., 3800 Race St., Denver, Colo.* Mine & Smelter has announced a new system for automatic opening and closing of pinch valves called the Massco-Grigsby Hydral 60 System. Described in Catalog No. 609, the System consists of one or more pinch valves with a single automatically operated hydraulic pump which may be operated by electric motor or by air from normal plant supply system. Reportedly, one of the important advantages of the system is the flexibility of the controlled circuitry to meet any operating requirements.

DUST COLLECTING, RECOVERY AND CLASSIFYING EQUIPMENT. *Buell Engineering Co., Inc., 123 William St., New York 38, N. Y.* Air pollution, material handling and classification, recovery of material from waste gases, and employe comfort are a few of the broad areas of application for Buell-Norblo equipment described in this bulletin.

SHAFT MOUNTED AND FLANGE MOUNTED DRIVES. *The Falk Corp., P. O. Box 492, Milwaukee 1, Wisconsin.* Bulletin 7100 presents shaft mounted drives and a new series of flange mounted drives covering a torque range up to 44,000 lb-in. Design and construction advantages are included as well as selection and dimensional data, engineering drawings, accessories, and typical application photos. Also explained and illustrated are the new Falk Equi-Poised Motor Mounts for use with Falk shaft mounted and flange mounted drives. These steel weldments are pre-drilled to accommodate rerated foot-mounted NEMA motors (½ to 30 hp).

CRAWLER SERIES. *The Eimco Corp., P. O. Box 300, Salt Lake City 4, Utah.* Bulletin L-1057, "Modern Profitable Mining Methods with the Eimco 630 Crawler Series," includes a short outline of the development of these crawler-mounted air or a-c electric powered machines, and illustrates the adaptability of the various units by pictures of the various attachments that can be mounted.

DRY SEPARATOR FOR COAL. *Ridge Equipment Co., P. O. Fallentimber, Pa.* Brochure describes and illustrates the Ridge Airjig, a dry separator for ⅝ in.—0 in. coal. All motors, variable speed reducers, blowers and controls are mounted

(More next page)

—ANNOUNCEMENTS—

National Mine Service Co., Pittsburgh, Pa., has announced it is moving its Greensburg Division manufacturing facilities from Greensburg, Pa., to the firm's Ashland, Ky., plant. The consolidated facility will be under the direction of **R. R. Schubert,** National Mine vice president who also is in charge of the company's Clarkson Division at Nashville, Ill.

Important organizational changes have been announced by **Harnischfeger Corp.,** Milwaukee, Wis. **William S. Burdick** has resigned as vice president of engineering to become corporate consulting engineer in which position he will counsel all major company functions in engineering. He will continue as a director. Elected as assistant to the president is **Bernard Pratte,** who since 1955 has been general manager of the company's Pacific division. **Robert D. Teece,** formerly assistant to the president, becomes vice president of engineering. **William L. Carter,** treasurer since 1959, has been appointed vice president of finance and treasurer.

Union Wire Rope Corp., a wholly owned subsidiary of **Armco Steel Corp.,** has been merged with the parent company, but will continue to operate as a separate unit and will continue sales activities with the same sales policies and personnel as in the past. **James H. Hatch,** president of Union Wire Rope, becomes general manager with the same responsibilities as before and **George P. Lacey** will continue to head the Union Wire Rope sales organization.

Bert H. Puerner, manager of special projects for **Allis-Chalmers International,** has retired after more than 40 years of service to the company. He had long been associated with pyro-processing machinery activities at Allis-Chalmers, specializing in the design and sales of cement plants. He holds several cement making machinery patents.

Erwin A. Wendell has been appointed manager of advertising and public relations for **Link-Belt Co.,** with headquarters at the company's executive offices in Chicago. The appointment follows the retirement of **Bertram V. Jones,** advertising manager for the past ten years.

Wendell first joined the company in 1917 as a member of the engineering department, moving in 1921 to the sales department. He served in a number of district offices until his assignment to the executive sales division in 1953.

C. S. Szekely, projects engineer, with **American Car & Foundry Division of ACF Industries,** is now associated with **The Watt Car and Wheel Co.,** Barnesville, Ohio.

Jack K. Adams, manufacturing manager at the No. 1 and No. 2 production plants of **Joy Mfg. Co.** at Franklin, Pa., has been named as works manager of these two facilities. He succeeds **George R. Fox,** recently appointed vice president of manufacturing for **Joy International, S. A.**

S. A. Bunis has been named sales manager of **Goulds Pumps, Inc.,** Seneca Falls, N. Y. Associated with the company for 23 years, he has held the position of assistant sales manager for the past four years. Prior to coming to the headquarters office in 1953, he travelled extensively as a sales representative in the New England and Middle Atlantic territories.

The **Austin Powder Co.,** Cleveland, has appointed **Clarence R. Ziegler** as southern district manager with headquarters in Knoxville, Tenn. His district includes Tennessee, Kentucky, West Virginia, Virginia, North and South Carolina, Georgia, Alabama, and Florida.

Jack L. Berkebile, associated for 24 years with **Penn Machine Co.,** of Pittsburgh and Johnstown, Pa., has been appointed as the company's sales manager, in charge of national sales to the coal, limestone, copper and potash mining industries.

(Continued from previous page)

on a common base with the separator, and the entire unit may be transported on a long wheelbase truck. The Airjig is available in three standard models from 35 to 75 tph capacities.

CABLE SUSPENSION SYSTEM. *Perfect-Line Mfg. Corp., Hicksville, N. Y.* The Line-Flex Cable Suspension System for mining and other industrial applications is included in this four-page catalog, which also describes Line-Fit connectors and Line-Strut accessories necessary to install the Line-Flex system. Given are charts on how to determine requirements as well as installation suggestions. The Line-Flex sheathing is described by the company as a modern method and means of suspending, permanently or temporarily, heavy electrical cable without need for special equipment, tools or training.

WET DRUM SEPARATORS. *Stearns Magnetic Products, 635 South 28th St., Milwaukee 46, Wis.* Entitled "Stearns Indox V, Type WPD, Wet Permanent Magnet Drum Separators," Bulletin 2013 gives complete specifications and dimensions on all sizes offered together with useful selection information. These units, available in both concurrent and counter-rotation styles in a variety of sizes, are used primarily as concentrators of magnetic ores and for the recovery of magnetic media in heavy-density separation systems.

POWER CENTERS. *News Bureau, General Electric Co., Schenectady 5, N. Y.* Bulletin GEA-7080 gives data on Cabinetrol Power Centers, which are engineered and custom-built to customer specifications. It describes special value of this equipment to applications where standard motor starters are interlocked and sequenced with specialized control functions for operation of complex industrial processes. Bulletin illustrates how unit is designed to centralize such functions as motor starting and control, power switching, circuit relaying and sequencing, motoring, process instrumentation and control of lighting and air conditioning. The equipment can be built for power concentrations up to 4000 amp.

ADJUSTABLE SPEED DRIVES. *The Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.* An extensive line of adjustable speed drives from this company are outlined in its Bulletin 2900. The drives have application in the ¾ to 2500-hp range, and the bulletin describes four types of complete packaged drives, giving details on available ratings, speed ranges, type enclosures, associated controls and many standard and special modifications.

HEAVY DUTY BLAST HOLE BITS. *Industrial Products Division, Security Engineering, P. O. Box 13647, Dallas, Tex.* Specifications and engineering data for Super-Aire heavy-duty blast hole bits are featured in the company's new mining and quarrying catalogue and air drilling guide.

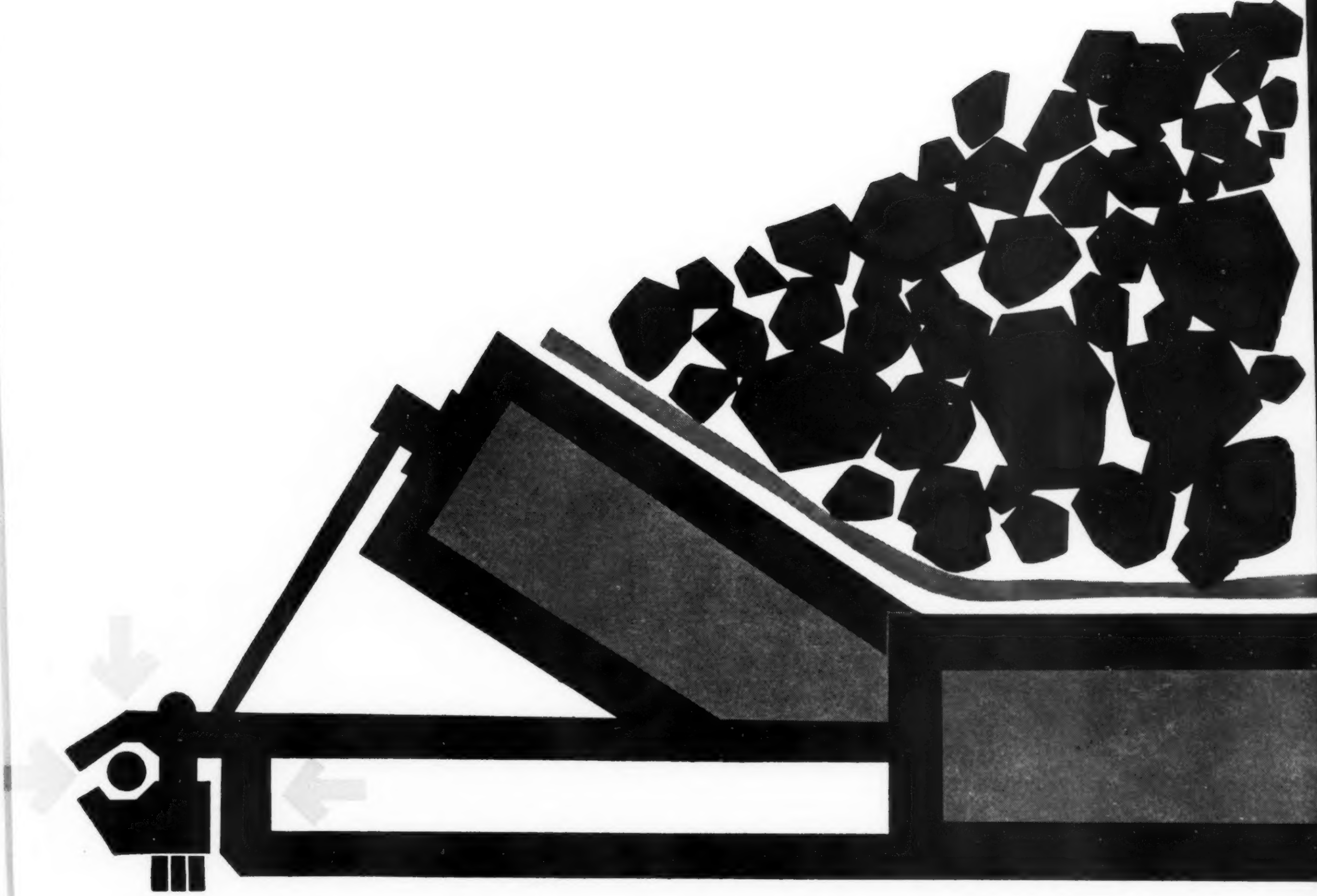
AIR CONTROL VALVES. *Hoffman Valves, Inc., 2360 West Dorothy Lane, Dayton 39, Ohio.* Presented in a single complete chart, in Bulletin 60–2, is the full Hoffman line of 2 Way, 3 Way, 4 Way, and 4 Way 5 Port poppet type valves. Air and solenoid pilot operators are illustrated and coordinated in the chart with compatible valves. Inline and sub-base mounted styles are covered. Cutaway drawings show construction features, sealing arrangements, poppets and flow pattern through valves in normal position.

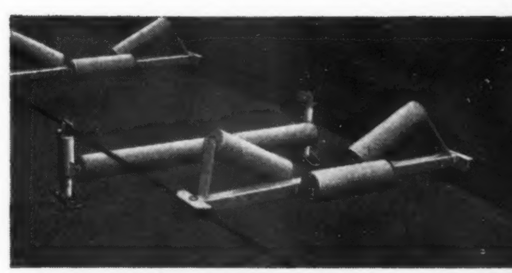
AIR FILTER. *Union Carbide Development Co., 270 Park Ave., New York 17 N. Y.* Text and illustrations describe advantages of the newly developed ULOK Panel-type Air Filter in ULOK Filter Bulletin A1. A diagram illustrates typical arrangements of this system and there is a data table listing capacities and resistances for the one and two-in. thick filters which come in nine sizes. The characteristics and qualities of the filter fiber are highlighted through performance and graphs and photo captions.

RECIPROCATING PLATE FEEDERS. *Chain Belt Co., Milwaukee 1, Wis.* Bulletin No. 6094P contains outlined drawings, dimensions, and selection aids covering the Rex Reciprocating Plate Feeders which are designed to feed a variety of materials, including coal, sand, ore and stone, from a bin and hopper. The bulletin also lists feeder specifications such as capacity and horsepower, and also features the five types of Rex eccentrics available for the feeder.

MINERAL AND CHEMICAL PROCESSING EQUIPMENT. *Denver Equipment Co., P. O. Box 5268 Denver 17 Colo.* Three new items are of particular note in Bulletin No. G3-B74, which outlines 44 different items of Denver equipment. These are the Denver SRL "Tru-Glandless" Pump, designed for installations where dilution of pulp with sealing water is prohibited; the Laboratory Flotation Machine, said to be capable of performing many laboratory flotation tests in one machine that previously required three different machines; and the Attrition Machine which operates with a pulp density at 70–80 percent solids to clean and polish sand by grain-to-grain attrition.

Index to Advertisers





New M-S-A® Pager gives you the convenience and flexibility of a telephone with the amplification of a loud speaker

Now, with one versatile communications unit, you can page key personnel over a loud speaker or converse semi-privately by phone. A flip of the switch on the new M-S-A Pager lets you do either.

Uses Existing Lines

The new unit is a completely self-contained, transistorized telephone. Individually battery-powered, these units utilize existing phone lines, and can be used in conjunction with most other telephones.

Simultaneous Paging

Ten or more Pagers can be installed on a single line. This makes it quite simple to page key men from a number of points . . . simultaneously. Once the man answers, a flip of the switch converts the Pager into a regular telephone for private or semi-private conversing.

24 Volts for Paging . . . 12 Volts for Talking

Two dry cell batteries provide the power source. And the power is expended only when the unit is in use, thus conserving battery life. Estimated battery life: 2 to 3 months on a 5% duty cycle.

Easy Installation and Maintenance

Weighing about 25 pounds, the M-S-A Pager can be mounted on a timber or a rib. All parts readily accessible with removal of four fastening screws which open the front half of the case. Transistors are vibration-proof . . . no filaments . . . so high efficiency, long life are assured.

For additional information, ask the MSA representative to call. And write us for helpful new product data bulletin.

Mine Safety Appliances Company, Pittsburgh 8, Pa. In Canada: Mine Safety Appliances Co. of Canada, Ltd., 500 MacPherson Avenue, Toronto 4, Ontario.